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SOME RADIOGRAPHICAL ASPECTS OF ILEUS[1]

by

Fredrik Koch

The roentgen-diagnosis of ileus is based on the characteristic distribution of gas and fluid in the intestine, as described by SCHWARZ (1911) and by KLOIBER (1919). The roentgenology of ileus as well as of other acute abdominal conditions has been up for discussion at a number of surgical and radiological congresses, with us in Scandinavia most recently in Oslo 1939. In the present paper it is intended *firstly* to touch upon some details concerning the distribution of gas in the intestine in two acute abdominal conditions with clinical features which are at times difficult to differentiate from ileus, viz. colicky pains due to calculus and acute inflammatory states within the abdominal cavity, and *secondly* to submit some points of view on the value of oral administration of opaque media in ileus.

Gallstone-colic is often difficult to obtain uncomplicated and, moreover, it more rarely comes under roentgen examination in the acute stage. Hence the best type-example would seem to be offered by attacks due to renal calculus. — It is true that among inflammatory conditions of the abdomen appendicitis is the commonest, but its clinical picture is often difficult to distinguish and its pathological anatomy is extremely variable, the same applying to acute cholecystitis. The most clear-cut is perforating ulcer, which has therefore been taken as the type of this category.

In the discussion on the gas distribution found in acute abdominal cases rather little importance would seem to have been attached to such an integrating factor as the time. As is known, the duration of the disease is of great importance for all clinical diagnoses, and this applies in a specially high degree to the acute abdominal cases, in which the clinical picture may change from hour to hour.

[1] Paper read at the Meeting of the Svensk Kirurgisk Förening in Lund on September 13, 1941; submitted for publication Sept. 29, 1941.

From the Roentgen-Diagnostic Department of the Lund Hospital (Chief: H. Hellmer, M. D.).

The estimation of the amount of gas present in the intestine must, of course, be subjective, there being no objective measure available. It has appeared simplest to use the following four degrees.

1. Little gas;
2. Moderate gas;
3. Much gas;
4. Meteorism.

Of course, the lines demarcating these four groups are floating. The following figures are intended to give some idea of the gas-amounts referred to in each case.

In order to form an idea of what distribution of gas can be expected in an attack of renal colic the roentgen pictures from 200 urographies from the years 1934—40 have been studied. All the cases were patients radiographed while the pains were in progress. The radiograms were all taken with the patient in the dorsal position and with the incident ray vertical.

The opinion put forward in the literature that metorism is a common phenomenon in renal colic is not borne out by this study. An analysis of the material shows that little gas was recorded in 86 cases (43 %), moderate gas in 68 cases (34 %), much gas in 38 cases (19 %), and meteorism in only 8 cases (4 %). Judging from this material, largish amounts of gas occur in the intestine only in every fourth case. The earlier view of meteorism in renal colic caused by calculus may be reasonably supposed to have arisen from the observations being made in a later stage of the disease. The present material is tabulated below to give some idea of the correlation between gas distribution and duration of the disease.

Gas Distribution in Attacks of Renal Calculus

	6 hrs	6—12 h.	12—24 h.	24 h.	
Little gas	64	16	4	2	
Moderate gas	14	28	15	11	
Much gas	1	7	12	18	
Meteorism	0	2	0	6	
	79	53	31	27	200

It will be seen that of 79 cases radiographed within the first six hours after onset of the attack, 64 showed only little gas in the intestinal canal, 14 a moderate amount. To the extent the limited material may justify a percentage calculation this would mean that 81 per cent of the renal colics examined within first six hours exhibited but little gas in the intestinal tube.

After this, the amount of gas increases with the duration of the disease; after 12—24 hours little gas is recorded only in four cases out of

Fig. 1.[1] Acute attacks due to renal calculus. Duration of disease 3 hours. Little gas.

Fig. 2. Acute attacks due to renal calculus. Duration of disease 8 hours. Moderate gas.

31, moderate in 15 and much gas in 12 cases. The significance of the time factor for the distribution of gas in the intestine would therefore seem to be clear.

The intensity of the pains has been considered to play a certain part in the origin of larger amounts of gas in the intestinal canal, probably by reflex action. Since the perception of pain is a symptom that is assessed very differently by different individuals, varying with sex, age, psychical character, etc., the value of this symptom is very difficult to judge.

During the years 1931—36 all clinically clear or suspected cases of *perforating ulcer* were systematically radiographed with regard to the occurrence of free gas in the abdomen. After this period only doubtful cases were sent for radiography, the clinically undoubted ones being operated upon immediately. The available material is further limited by the fact that at the examination for free gas pictures were frequently taken merely of the subdiaphragmatic portions of the abdomen. The

[1] Due to a regrettable mistake all the pictures have been turned so that the organs reproduced are seen from behind.

Fig. 3. Acute attacks due to renal calculus. Duration of disease 14 hours. Much gas.

Fig. 4. Acute attacks due to renal calculus. Duration of disease 36 hours. Meteorism.

material brought together for this investigation is derived from the period 1934—41 and comprises 47 cases grouped as follows:

Ulcus ventriculi perf.	17 cases
Cancer » »	3 »
Ulcus duodeni perf.	25 »
Ulcus pept. jejun. perf.	2 »

Of the 47 cases composing the material, 13 had come in three hours after the perforation, and 31 within the first six hours.

The distribution of gas in perforating ulcer seems to agree with that found in renal colic due to stone: the longer the time that has elapsed after the perforation the larger will be the collection of gas in the intestine. Unfortunately the small extent of the material gives the figures only a limited range.

	< 3 hrs	3—6 h.	6—12 h.	> 12 h.	
Little gas	9	8	1	2	
Moderate gas	4	4	6	—	
Much gas	—	6	2	2	
Meteorism	—	—	2	1	
	13	18	11	5	47

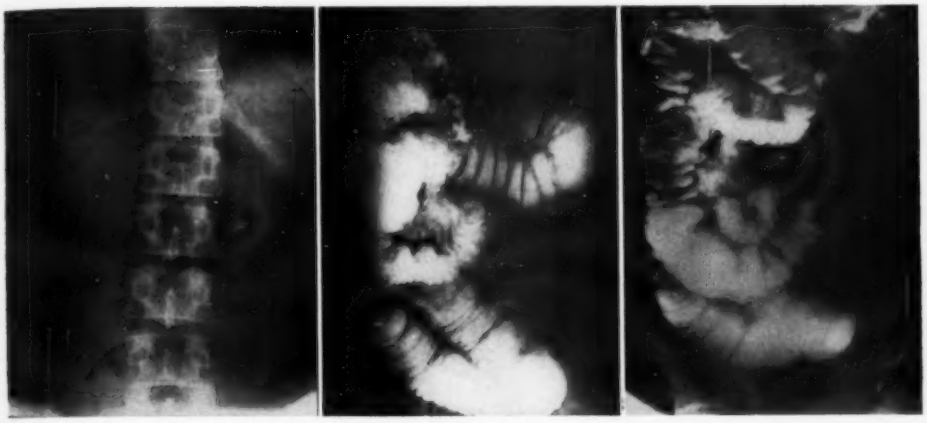

Fig. 5. Fig. 6. Fig. 7.

Fig. 5. G. R. man 25 years (surg. journ. 3710/40) 14 hours ileus symptoms; Standing position.

Fig. 6. Same patient, three hours after administration of opaque medium pr os.

Fig. 7. Same patient, height hours after the contrast-meal, no aboral progress of the medium. Obstruction at the level of the umbilicus.

It should be noted that the three late cases with little gas were all »covered perforations».

In the way the roentgen examination is usually carried out in ileus it presents a cross-section view of the pathophysiological events at a certain moment. The single picture tells nothing as to in what phase the process is, nothing of its dynamics. From a single picture no conclusions can be drawn with regard to the prognosis, and no knowledge can be gained as to whether the condition is caused by a relative or an absolute obstruction. With the aid of the radiogram the presence of an obstruction, its probable position, and sometimes also its nature may be inferred. By means of an opaque enema the site can be described more closely and the nature of the obstruction be further elucidated — so far as the colon is concerned (e. g. intussusception, volvulus). Ileus of the small bowel cannot, of course, be tackled by this method.

It is the continued observation of the case which can provide further information of the state. From a clinical point of view, on the other hand, delay in adopting active therapy may entail great risks, and the general view among surgeons is no doubt that once an ileus condition is established the case must be operated on as soon as possible, some even considering that the short delay associated with a single roentgen examina-

Fig. 8. G. N. man 59 years (surg. journ. 4526/38) Admitted after 9 ½ hours ileus symptom.

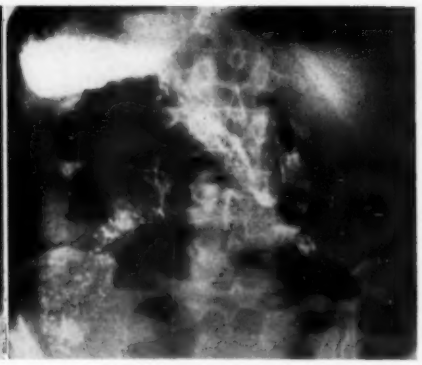

Fig. 9. Same patient. Two hours after contrast-meal: the medium is still in the stomach the fluidlevels increased.

tion is of evil. However, the opinion is beginning to gain ground that an roentgen examination of the abdomen ought always to be undertaken on suspicion of ileus and that the value of this examination can even be compared to aerial photography of the territory to be attacked in warfare. The aim should be to get every patient with ileus under roentgen examination; the *state* in which the patient is may afterwards decide if recourse is to be had to surgical measures or if the case can be placed under observation for some time.

In this connection only a few details of the richly faceted radiogram in mechanical obstruction of the small intestine will be considered, and as a prototype choice has been made of that due to bands and adhesions. The material is derived from the years 1930—40. It does not contain such cases as owed their origin to cancer or tuberculosis, nor such ileus conditions as occurred in immediate attendance upon operations. All the cases have undergone operation.

A more consistent recourse to radiography in ileus has been made during the last ten years: whereas during the years 1920—30 only 12 cases were radiographed of the 83 operative cases due to adhesions, during the years 1930—40 there were 62 roentgen examined cases out of 75 operation cases; among the 13 non-radiographed cases a laparotomy was done in seven on a suspicion of appendicitis. Of the 62 radiographed cases of ileus due to adhesions, no fewer than 23 had been followed by means of opaque media administered by mouth.

This group of 23 ileus cases examined as to intestinal passage were patients who had been suffering from their obstruction for 4 to 48 hours,

Fig. 10. Same patient. Two hours later: the medium has reached the lower loops of the ileum.

Fig. 11. Same patient. Nine hours after the administration: the opaque medium is over in the colon.

one rather subacute case for 5 days, before they had come in for roentgen examination. Twelve of the cases were clinically clear, eleven had a clinical diagnosis of suspected obstruction; the radiogram (plain photos) showed in all cases thé picture of obstruction of the small intestine. As the patients were only slightly affected, it was considered expedient to await developments and to follow the passage of a small quantity of opaque medium introduced by mouth, under careful clinical and radiological control.

The expectant treatment to which these patients were submitted through the passage-examination amounted to between 2 and 48 hours. In ten of the cases the examination with opaque medium gave a substantially clearer diagnostic conception, and in the majority of cases gave information of such a nature that the site and character of the obstruction could be more closely defined.

A short account of one of the cases belonging to this group is submitted below.

Surgical Journal. 3710/40. G. R., male aged 25 years, who had previously had pains of a rather diffuse character in the abdomen; roentgen examination of intestinal passage two weeks earlier showed nothing untoward. Admitted, after 14 hours of successively increasing ileus distress, in a good general condition with slight distension and slight, diffused tenderness of the abdomen. Under a clinical suspicion of intestinal obstruction the patient was sent for roentgen examination: a small amount of gas was detected in two loops of the small bowel in the left hypochondrium and fluid levels were observed in these loops in patient's standing position. (Fig. 5.) Three hours after administration to an opaque medium the latter could be observed in the abnormally dilated loops of the small gut. (Fig. 6). Eight hours later, the medium had made but little further aboral

progress; at the level of the umbilicus the lumen of the intestine was contracted, while orally to this point there was continuous dilatation. (Fig. 7). Clinically, the patient still presented no obvious meteorism, the general condition remained unaffected, the pains were moderate. At the operation then undertaken an absolute obstruction was found in the small bowel at the spot indicated by the roentgenrays.

The primary mortality in these expectantly treated cases amounted to 6 deaths out of 23 operated cases (in the 39 not followed with opaque medium 12 deaths). The cause of death was cardiosclerosis in two cases (patients aged respectively 70 and 75 years), in one case pulmonary embolism, in one anaerobic infection of the abdominal wall (after passage had been established), and in both the remaining cases peripheral vascular collapse (one 14 hours after the operation, which was performed after 24 hours' expectant treatment following upon 18 hours' illness; the other had a fatal issue 11 days after the operation).

The difficulties of distinguishing between absolute and relative obstruction on the basis of the clinical and radiological status, and the value of oral administration of opaque media in such cases, can be illustrated by the following material. This group comprises 21 cases from the years 1936—40 in which the diagnosis of intestinal obstruction was made on the clinical symptoms and was corroborated by the roentgen finding of distended small-bowel loops and fluid levels. The patients had then been ill for six hours to $4^1/_2$ days; two-thirds of them had previously undergone abdominal operation. The justification for venturing upon expectant treatment was, as in the former group, a relatively unaffected general condition. The patients were carefully watched both clinically and radiologically. During this expectant treatment passage was re-established; no deaths were registered.

From this group of passage-followed, non-operated cases of intestinal obstruction the following may be adduced as an example.

Surg. journ. 4526/38. A 59-years-old man, who had previously been healthy, was admitted after $9^1/_2$ hours of typical ileus symptoms under a picture of a moderately affected general condition and slightly meteoric abdomen with palpable viscus in the left iliac fossa. Roentgen examination revealed small-bowel loops dilated to the thickness of a wrist-joint and containing fluid levels. (Fig. 8). The patient was requested to drink a small amount of the opaque medium: on examination two hours later the medium was still left in the stomach, the fluid levels had increased, but otherwise the ileus picture was unchanged. (Fig. 9). Clinically the patient was still unaffected, the meteorism was less. After another two hours the condition had improved further; on the radiogram the opaque medium had reached the lower loops of the ileum (Fig. 10), and after a further five hours (nine hours after admission) the opaque medium was in the colon. (Fig. 11).

Besides the cases collected here, several others, e. g. with postoperative passage difficulties, were given an opaque medium. No injurious effects were observed to follow peroral administration of the opaque substances. The control, both clinical and radiological, must be extremely scrupulous and consistent.

These two groups of material may be considered to show that administration of opaque medium by the mouth in acute conditions of intestinal obstruction is not fully so risky as is usually alleged, and that by this means laparotomy can be avoided in quite a number of cases of relative obstruction. The prerequisite for a successful expectant treatment of this kind in a *per se* so acute abdominal condition is the most intimate collaboration between clinician and radiologist.

SUMMARY

On the basis of cases of acute kidney troubles due to kidney stones and of cases of perforated ulcers the author proves the importance of the duration of the affection with regard to the distribution of intestinal gases in cases of spontaneous intestinal affections. These last years the method of examining cases presenting a small intestine in mechanical surroundings with the help of contrast medii grew more and more popular. This way of procedure improves the possibility of establishing a correct diagnosis. In 21 cases presenting clinical symptoms either permitting of a correct diagnosis or suggesting the presence of mechanical ileus and in which this condition was verified at the roentgenological examination, the examination with the aid of contrast medii revealed that the ileus was relative and did not call for immediate intervention. The determination whether operation should be performed or might be postponed depends largely on the general condition of the patient and of a careful follow-up study of the clinical picture and of the findings in the radiogram which the clinician should carry on in close collaboration with the roentgenologist.

ZUSAMMENFASSUNG

An dem Beispiel des akuten Nierensteinanfalles und des perforierten Ulcus weist der Verfasser die Bedeutung der Erkrankungsdauer für die Verteilung der Darmgase bei akuten Bauchaffektionen nach. — Während der letzten Jahre wurden immer mehr Fälle von mechanischem Dünndarmileus mit Hilfe von Kontrast untersucht. Hierdurch konnte die Diagnostik verbessert werden. Bei 21 klinisch sicheren oder verdächtigen und röntgenologisch verifiziertem mechanischen Ileus erwies sich bei der Kontrastuntersuchung, dass dieser relativ war und somit nicht sofort operiert werden musste. Die Voraussetzungen für ein derartiges Abwarten ergeben sich aus dem Allgemeinzustand des Patienten und einer sorgfältigen klinischen und röntgenologischen Kontrolle, die nur durch äusserst ntime Zusammenarbeit zwischen Kliniker und Röntgendiagnostiker erreicht werden kann.

RÉSUMÉ

Se basant sur les cas d'attaques aiguës due à des calculs du rein et sur les cas d'ulcères iperforés l'auteur prouve l'importance que prend la durée de l'accident à l'égard de la distribution des gaz intestinaux en présence de maladies aiguës de l'abdomène. Les dernières années on utilisa de plus en plus les liquides opaques pour examiner les cas qui présentaient un intestin grêle dans un milieu méchanique. Cette méthode faciliterait le diagnostic qu'on pourrait de plus porter d'une manière plus précise. Chez 21 cas présentant un tableau clinique tel qu'on pouvait porter un diagnostic précis ou qui indiquait la présence d'un iléus et chez qui l'examen radiographique vérifia le diagnostic, l'examen à l'aide des solutions de contraste aurait révélé que l'obstruction intéstinal n'était que relative et n'exigeait pas une intervention immédiate. La determination opératoire s'appuierait sur l'état général du malade et sur les résultats d'une soigneuse étude du tableau clinique et des symptômes radiologiques, une étude qui exige une collaboration intime de la part du clinicien et du radiologiste.

AUS DEM KOMM. KRANKENHAUS IN ÅLESUND (CHEF: DR. E. HJORT)

ARTHROGRAPHISCHE UNTERSUCHUNGEN DES SCHULTERGELENKS, MIT SPEZIELLER RÜCKSICHT AUF DIE RUPTUR DER SEHNEN DESSELBEN[1]

von

H. Frostad

Seit den letzten paar Dezennien ist viel von Schulterschäden geschrieben worden. Der Pionier auf diesem Gebiet ist E. A. CODMAN, dessen erster Aufsatz darüber sich vom Jahre 1906 datiert. Von der Zeit an hat er sein Leben so zu sagen der Pathologie der Schulter gewidmet. Sehr interessant ist die Beschreibung der Bursa subacromialis und deren Beziehung zur Ruptur der Sehne des Musc. Supraspinatus.

Bei Schulterschäden ist die Ruptur der Sehne des Supraspinatus sehr häufig, und eine ernste Komplikation mit hoher und dauernder Invalidität. CODMAN sagt: »Meine eigenen Untersuchungen haben mich zu der Überzeugung gebracht, dass die Ruptur der Supraspinatussehne weit die gewöhnlichste Ursache der industriellen Schulterschwäche ist, und die Schulter schwächer macht, als nach Fractura humeri oder Luxatio humeri.»

Wenn man in einem frühen Stadium die Ruptur entdeckt, ist es leicht, sie zusammenzunähen und der Erfolg wird gewöhnlich volle Funktion der Schulter sein. Die Sutur einer alten Ruptur ist schwieriger und der Erfolg nicht so gut.

CODMAN und nach ihm mehrere noch, haben die Diagnose bei den gewöhnlichen klinischen Untersuchungen gestellt. Patienten mit Supraspinatusruptur können schwer den Arm auswärts—aufwärts über die Horizontale heben, und indem die Horizontale passiert wird, werden intensive Schmerzen in der Schulter fühlbar, man hört oft einen kleinen Knick, indem das laterale Sehnenstümmelchen unter den Acromion hinunterschlüpft. Auf der Rupturstelle, gleich lateral des Acromion, wird man oft eine kleine Vertiefung bemerken, und an derselben Stelle ist deutliche Empfindlichkeit gegen Druck. Der humeroscapulare Rythmus ist gestört, und der Patient ist schwerer Arbeit wenig fähig.

[1] Bei der Red. am 28. X. 1941 eingegangen.

Klinisch ist doch die Differenzialdiagnose zwischen anderen krankhaften Änderungen an der Schulter mit ähnlichen Symptomen schwierig. Es ist daher von grosser Bedeutung, dass man jetzt eine sichere röntgenologische Diagnose stellen kann. Zu diesem Zweck hat man an dem Krankenhaus Ålesund seit 1938 mit Arthrographie und Obduktion der Leichname Versuche getrieben und späterhin arthrographische Untersuchungen Lebendiger.

Seither sind indessen auf diesem Gebiete grundlegende Arbeiten von LINDBLOM hinzugekommen. Gleichfalls Arbeiten von PETTERSON OTNES und HAREIDE.

Diese vorliegende Arbeit ist auf dem Studium der normalen und pathologischen Verhältnisse bei 42 Sektionpräparaten des Schultergelenks aufgebaut, alle arthrographisch untersucht, und in 9 Fällen fand sich Ruptur der Sehnenmanschette des Gelenks. 87 Patienten sind arthrographisch nach Schulterschäden untersucht worden. In 27 Fällen fanden sich Rupturen, wovon 15 operativ verifiziert wurden. In 10 Fällen gab es inkomplette Rupturen. In 50 Fällen wurde keine Ruptur vorgefunden, 2 davon wurden operiert.

Um besser die röntgenologische Untersuchung verstehen zu können, werden zuerst einige einfache Verhältnisse vom Schultergelenk und Bursa subacromialis erwähnt werden. Dies, sowohl das klinische Bild als die Operation der rupturierte Supraspinatussehne, sind im Februar 1941 in Norsk Kirurgisk Forening vom Herrn Chefarzt E. HJORT genau besprochen wurden.

In den meisten anathomischen Werken sind eine Bursa subacromialis, eine Bursa subdeltoidea samt einer Bursa subcoracoidea beschrieben worden. Nach CODMAN sind diese Schleimbeutel so got wie immer zu einer grossen Bursa subacromialis mit einander verbunden, und in diesem Aufsatz wird dieser Terminus benutzt werden. Die Gelenkkapsel der Schulter ist in ihrem oberen, hinteren und vorderen Teil mit den flachen, ausgespannten Sehnen der Muskeln supraspinatus, infraspinatus, teres minor und subscapularis zu einer einzigen grossen Sehnenfläche, die sich an den Collum anathomicum befestigt, untrennbar zusammengemischt. Der Boden des grossen Bursa subacromialis ist mit dieser Sehnenfläche fest verbunden und liegt distalter am Tuberculum majus und Collum chirurgicum humeri an. Das Dach liegt an der unteren Seite des Acromion und des Deltoideus an. Wenn die Supraspinatussehne bricht, reisst sie auch den Boden der Bursa und die Kapsel des Schultergelenks mit, und eine direkte Kommunikation zwischen dem Schultergelenk und Bursa tritt ein. Fig. 1. zeigt ein anathomisches Präparat der durchsägten, normalen Schulter. Man sieht die Bursa, die über dem oberen lateralen Ende des Humerus von der unteren Seite des Acromion bis zum Collum chirurgicum sich schalenförmig erstreckt.

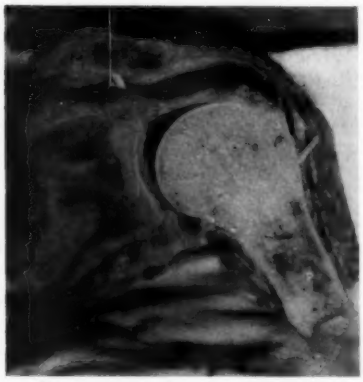

Fig. 1. Schultergelenk im Frontalplan durchgesägt.

Nach den Untersuchungen RUBER ist die Grösse der Bursa sehr wechselnd. THOMAS hat davon Abgüsse gemacht, mit dem Zweck ihre Grösse zu ermessen.

Bei Obduktion, oder bei Operation einer Supraspinatusruptur, ist man immer erstaunt, wie gross und weitgedehnt doch die Bursa in der Tat ist. Wenn sie auf dem Röntgenbild, bei Untersuchung Lebendiger, immer kleiner erscheint, muss die Ursache die sein, dass es wegen des Muskeldrucks schwer ist, sie ganz zu füllen. Man erreicht wohl einen kleineren zentralen Teil zu füllen, während die peripherischen Teile davon zu dem Kapilaren Spalt zusammengedrückt liegen, der ihr normaler Lumen ist. Ihre Grösse röntgenologisch darzustellen ist deshalb schwer, ausser an Leichnamen. Fig. 2 zeigt eine normale Bursa, mit Lipiodol gefüllt. Das Präparat ist einem Leichnam entnommen, einem 71-jährigen Bauern, an intercurrenter Krankheit gestorben. Auf dem Seitenplan sieht man, dass ungefähr zweidrittel davon unter dem Acromion hineindringt, während der übrige Teil davon über der lateralen Partie des Caput, des Collum anath., des Tuberc. majus und des Collum chirurgicum sich haubenförmig wölbt. Auf einer Röntgenaufnahme, gerade von oben gemacht, sieht man, dass er unter dem Gelenk des Acromioclavicularis und dem lateralen Ende der Clavicula hinuntersteckt. Die laterale Grenze des Acromion tritt durch eine deutliche Furche im Lipiodol hervor. Fig. 3 zeigt die Bursa und eine typische alte Ruptur der Supraspinatussehne bei einem 65-jährigen Werftarbeiter, nach intercurrenter Krankheit verschieden. Die Fasern des Deltoideus sind der Länge nach gespalten. Die lateralen Enden der Clavicula und des Acromion sind durchgesägt und gehoben. Das mediale Ende ist ausgerundet und abgeschliffen, das periphere Ende ist ganz athrophiert, und Collum anathomicum mit Tuberc. majus liegt nackt da. Am Boden sieht man einen Teil des Caput humeri. Den glatten Boden der Bursa sieht man nach beiden Seiten unter den Deltoideusfasern, medial und vorwärts unter dem Acromion und dem Ligamentum corocoacromiale sich fortsetzen.

Den endgültigen und entscheidenden Beweis, dass die Ruptur vorliegt, erhält man bei Arthrographie des Schultergelenks. Wie oben erwähnt, wird in und mit der Ruptur eine direkte Kommunikation zwischen der Gelenkhöhle und der Bursa gebildet. Diese Verbindung

Fig. 2. Schultergelenk eines Gestorbenen. Bursa subacromialis mit Lipiodol gefüllt.

a. Seitenplan.
b. Von oben gesehen.

Fig. 3. Schultergelenk eines Gestorbenen mit typischer alter Ruptur der Supraspinalussehne. Musc. Deltoideus und Bursa subacromialis die Länge nach gespaltet. Acromion und Clavicula durchgesägt und etwas gehoben. S. sp. Tend. musc. Supraspinatus. cap. h. Caput humeri. Lig. c. ac. Ligamentum coracoacromiale. Col. anat. Collum anatomicum. m. delt. musculus deltoideus. ac. acromion.

nachzuweisen ist das Ziel unserer Untersuchungen gewesen. Wir haben da vorausgesetzt, dass es durch die Sehnenmanschette und die Gelenkkapsel keine normalen Warianten mit mitgeborenen Öffnungen gibt.

Lindblom und Palmer haben darauf Gewicht gelegt, die Rupturstelle als einen Füllungsdefekt in der Sehnenmanschette feststellen zu können. Sie füllen das Gelenk mit Kontrast, durch Punktion desselben, eben lateral und vorwärts des Acromion. Die Nadel wird eingestochen, direkt durch die Wände der Bursa, bis sie Knochenwiderstand in Caput humeri antrifft. Die Nadelspitze steht da im Knorpel begraben und wird zurückgezogen, bis sie in der Gelenkhöhle zu liegen vermutet wird. Durch

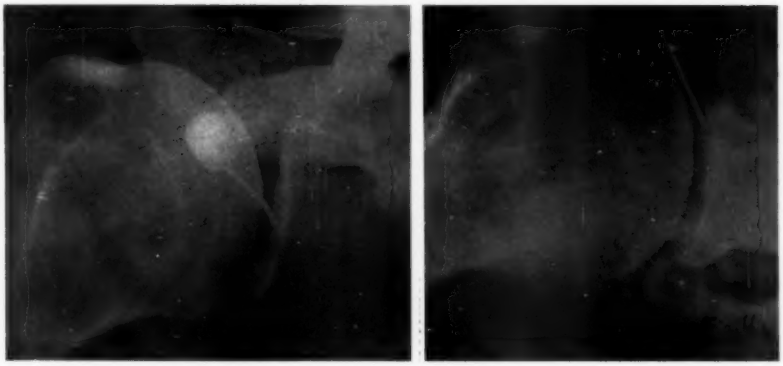

Fig. 4. Die Stellung der Nadel bei der Einspritzung von Kontrast a. Seitenplan. b. von Akselhöhle nach oben gesehen.

Aufnahmen in verschiedenen Rotationstellungen kann man sehen, ob die Ruptur nach vorne im Subscapularis, nach hinten im Infraspinatus oder gerade im Frontalplan im Supraspinatus liegt.

Das Prinzip unserer Untersuchung ist: Punktion des Schultergelenks von vorne, ausserhalb des Bereichs der Bursa, mit Luft und Perabrodil-injektion, oder nur mit Luft, was sich da zwischen Gelenkhöhle und Bursa verteilt, wenn Ruptur mit Kommunikation vorliegt. Bei Untersuchungen an Leichnamen wurde zuerst Punktion der hinteren Fläche des Gelenks versucht, und dies schien das Idealste zu sein. An Lebendigen aber misslang es sehr oft. Punktion der Gelenkhöhle von oben durch die Bursa gleich lateral des Acromion gelang ziemlich leicht. Es ergab sich aber mehrmals, sowohl an Leichen als an Lebendigen, dass man die Füllung der Bursa erreichte, ohne dass wirkliche Ruptur vorhanden war, indem Luft und Kontrast durch das Loch des Nadelstiches zurückströmten. Das wird auch von LINDBLOM hervorgehoben. Die Punktion der Bursa selbst misslang sehr oft, auch an Lebendigen. Die Punktion des Gelenks von vorne ergab sich als das einfachste. Es hat immer zum Ziel geführt.

Findet man, dass Kommunikation da ist, bedeutet das folglich Ruptur, was die endgültige Indikation für operativen Eingriff gibt. Nach dem kleinen Schnitt CODMANS erhält man den Überblick über die ganze Sehnenmanschette, sowohl dem Subscapularis als dem Supraspinatus und dem Infraspinatus entsprechend, durch das Rotieren des Armes nach auswärts bzw. inwärts. Unserer Meinung nach hat es also gar keine Bedeutung, im voraus festzustellen, wo die Ruptur sitzt da die Operationstechnik auf alle Fälle dieselbe wird.

Untersuchungstechnik: Der Patient wird am Rücken angebracht, man hebt mit einem Kissen die frische Seite, so dass die Rückenfläche

einen Winkel von 30 Grad mit der Horizontalen bildet. Bei Durchleutung wird nun der Arm des Kranken so gelegt, dass die Gelenkfläche des Schulterblattes vertikal gestellt und der Gelenkspalt sichtbar wird. Dies erzielt man oft am besten durch das Anbringen des entspannten Armes am Rumpf, mit einer rechtwinkligen Biegung im Ellbogen und der Hand auf dem Bauch, oder durch das Anbringen des ausgestreckten und entspannten Armes in 45—60 Grad, Abduktion auf dem Tisch. Bei Durchleutung wird die Lage des Gelenkspalts markiert, und die Nadel wird, unter ein wenig Lokalanestesie gegen die Mitte desselben geführt, so dass sie gerade nach vorne mit dem Plan des Gelenkspalts einen Winkel von 10—15 Grad bildet. Fig. 4 a. Indem die Nadel durch die Kapsel geführt wird, zuckt der Patient und verrät Schmerzen. Nach RAUBER KOPSCH sind nämlich die Gelenkkapsel und die Sehnenbefestigungen um das Schultergelenk mit Vater-Paccinischen Gefühlkörpern und Golgischen Sehnenspindeln reichlich versehen.

Die Nadel wird gegen den Gelenkspalt geführt, bis sie Knochenwiderstand an der Cavitas glenoidalis antrifft. Die Nadelspitze wird da gewöhnlich im Gelenkknorpel über der Gelenkpfanne verborgen stehen. Wenn man eine dünne und quergeschliffene Nadel benutzt, muss man sie 2—3 mm. zurückziehen. Wenn man aber eine Nadel mit langgeschliffener Spitze verwendet, wird die Öffnung ausserhalb des Knorpels reichen und sich in der Gelenkhöhle befinden. Man muss beachten, dass die Nadelöffnung lateral, von dem Knorpel der Gelenkpfanne gedreht wird. Fig. 4 b. Versucht man nun ein bisschen Luft zu injizieren, strömt sie ohne Widerstand ein, und entfernt man die Spitze, sickert die Luft mit vernehmbaren Laut und als schäumende, blasengefüllte Flüssigkeit durch die Nadel heraus.

Spritzt man 5 cc. Luft hinein, sieht man bei Durchleutung, dass die Luft den axillaren Gelenkbeutel ausfüllt, und wenn Ruptur da ist, strömt sie sogleich dadurch und füllt die Bursa. Insofern genügt es mit Luftinjektion, da der Zweck der Untersuchung ja schon erreicht ist. Man muss da im ganzen 10 cc. Luft injizieren. Wenn man 10 cc. Luft und hinterher 5—6 cc. Perabrodil injiziert. bleibt die Luft in der Mitte liegen, während der Kontrast längs der Ränder eine dünne Fütterung legt, und man erhält ein schönes und deutliches Bild von der Bursa und von der Gelenkhöhle. Man kann auch die Luft wieder herausströmen lassen und dann hinterher 5—6 cc. Perabrodil injizieren. Die Verteilung der Kontraste zwischen der Gelenkhöhle und der Bursa geschieht nun bei Ruptur ungefähr ebenso schnell wie bei Luft.

Nachdem man den Kontrast oder die Luft deponiert hat, zieht man die Nadel zurück und macht ein paar Bewegungen im Schultergelenk um den Kontrast zu verteilen. Dann macht man Aufnahmen von der Schulter, eine mit dem Arm innen rotiert, eine in mittlerer Rotationsstellung und

eine stark nach aussen rotiert. Dadurch erhält man die Übersicht über den hinteren Teil des Tuberculum majus, bzw. den vorderen Teil desselben, und den Tuberculum minus, mit den Sehnenbefestigungen der entsprechenden Muskeln, samt dem hinteren, mittleren und vorderen Teil der Bursa und der Bicepssehne. Eine gute Übersicht über die Bicepssehne erreicht man, wenn man die Aufnahme des Schultergelenks macht, indem der Patient, den Oberkörper 45 Grad gedreht, die kranke Schulter vorwärts und den Oberarm nach aussen rotiert, dasitzt.

Man hätte glauben sollen, dass kleine Risse und Kanäle in der Sehnenmanschette durch die Mischung von Luft und Kontrast schwer anzugeben wären. Dies ist doch nicht der Fall. Wenn nämlich der Kanal eng ist, legt sich längs seiner Ränder immer Kontrast, und wenn in seinem Lumen für Luft kein Platz ist, tritt er als ein rein kontrastgesättigter Streifen hervor.

Perabrodil wird schnell resorbiert, und schon nach 15—20 Minuten ist es unmöglich, irgend einen Kontrast sehen zu können.

Doch die Luft kann sich dort ein bisschen länger halten. Das Wesentlichste davon ist doch auch nach etwa 30 Minuten verschwunden. Nach dieser Zeit kann man mehreren Stunden lang einen schmalen Luftstreifen in dem axillaren Gelenkbeutel sehen, seltener aber in der Bursa. Die Luft wird nämlich durch das Nadelstiches ausgedrückt. Die Schnelligkeit, mit der es geschieht, ist, wenn man eine dicke Nadel benutzt oder aber mehrmals durch die Kapsel gestochen hat, grösser als durch den Gebrauch einer dünnen Nadel und durch nur einen Stich. Ausserdem verschwindet sie schneller bei einem Patienten mit kräftiger Muskulatur als bei einem mit einer schwächeren. Die Luft versammelt sich meistens unter Musculus pectorales oder in der Axille, seltener aber unter Musculus deltoideus. Hier kann sie seit mehreren Stunden liegen bleiben, und ist sogar 24 Stunden nach der Injektion nachgewiesen. Der Patient wird es aber kaum fühlen und hat gar kein Unbehagen daran.

Untersucht man dagegen einen frischen Schulterschaden mit Ruptur der Supraspinatussehne, wird man sehen, dass ins Gelenk injizierte Luft ziemlich schnell verschwindet, längs dem Humerus, zwischen der Knochenhaut und den Muskeln. Hieraus muss man schliessen, dass bei Schäden, die Ruptur der Supraspinatussehne verursachen, auch Risse und Spalten in der Kapsel sonst vorkommen, und dass die Luft dadurch passiert.

Die Reaktion der Untersuchung ist unbedeutend. Nach der Perabrodilinjektion gibt es gewöhnlich während der ersten 24 Stunden leichte Schmerzen in der Schulter, infolge der Irritation der Synovialhaut und vergrösserter Absonderung der Gelenkflüssigkeit. Die Schmerzen sind doch immer nach ein paar Novaætyltabletten oder nach 20—30 Tropfen 1 % Morphin beseitigt worden. Es war nie nötig, das Schultergelenk

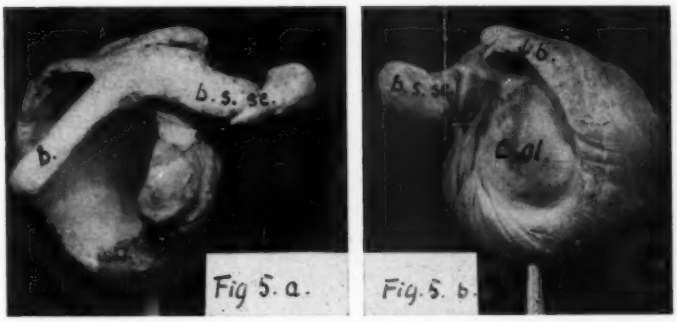

Fig. 5. Abguss der Gelenkhöhle. Fig. 5 a. Laterale Seite. Fig. 5 b. Mediale Seite. a. Axillare Gelenkbeutel. b. Vagina mucosa tend. m. bicipitis. b. s. sc. Bursa subscapularis. c. gl. Cavitas glenoidalis. t. Tendinis musc. subscapularis.

wegen der vergrösserten Exudation zu punktieren, was nach Arthrographie des Kniegelenks, ohne nachfolgende Operation, dann und wann eintreffen kann. In den Fällen, wo operiert wird, ist das regelmässig am Tage nach der Arthrographie vorgenommen worden. Beim Öffnen der Bursa und des Gelenks findet man da eine etwas vergrösserte Absonderung der schleimartigen Gelenkflüssigkeit, aber keine Injektion oder keine geschwulst der Bursawände oder der Synovialhaut der Schulterkapsel.

Wenn man nur Luft verwendet, tritt überhaupt gar keine Reaktion ein. Arthrographie mit sowohl Luft als auch Perabrodil ist mehrmals ambulant gemacht worden.

Bei Untersuchungen unterscheidet sich das Aussehen der Bursa bei Lebendigen viel von demselben der Leichname, hauptsächlich an Grösse. Dies beruht auf dem Druck und der Elastizität der Gewebe, aber auch darauf, dass man bei einem Leichnam einen mehr Schattengebenden Kontrast, wie Lipiodol, verwenden kann. Die Bursa zeichnet sich auf dem Röntgenogram im Seitenplan wie ein kontrastgesättigter Schatten ab, in der Form des Neumonds. Die Breite ist dem Füllungsgrade nach wechselnd. Benutzt man Luft, ist er blasenförmiger. Seine konkave Fläche ist immer nach unten gekehrt und erstreckt sich vom lateralen Ende des Acromion, über Caput, Collum anathomicum, Tuberculum majus und Collum chirurgicum humeri. Diese Fläche liegt regelmässig in einer Entfernung von 2—4 mm. von den Knochenteilen. Die Entfernung hängt doch viel von der Rotation des Armes und dem Füllungsgrad der Bursa ab. Oft sieht man unter dem Acromin einen Streifenkontrast, der sich ans Acromioclaviculargelenk medial erstreckt, und lateral mit dem sichelartigen Schatten in Verbindung steht. Es ist den

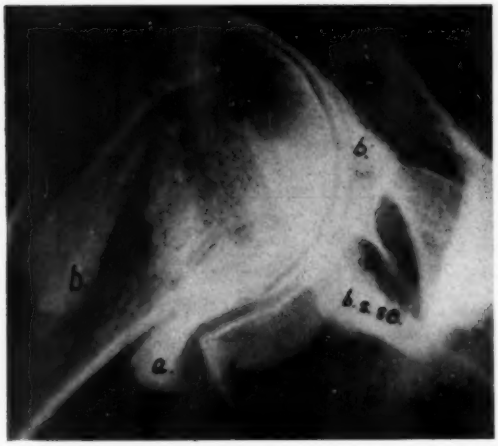

Fig. 6—8. Normales Arthrogram.

a. Axillare Gelenkbeutel.
b. Tendinis Bicipitis longus mit Vagina mucosa.
b. s. sc. Bursa subscapularis.

Teil der Bursa, der unter der Schulterhöhe und dem lateralen Ende der Clavicula liegt. Fig. 10—13—14.

Um eine gute Füllung der Bursa zu erzielen, ist es von grosser Bedeutung, dass man den Patienten die Muskeln im Schulterbogen, besonders den Deltoideus, entspannen lässt. Bei Durchleutung kann man nämlich sehen, dass der Inhalt, sobald der Patient die Muskeln strafft oder den Arm abduziert, von der Bursa in die Gelenkhöhle gedrückt wird, nur einen schmalen Kontraststreifen hinterlassend. Bei ganz entspannten Muskeln wird er besser gefüllt, und wird breiter.

Das Merkwürdige bei dem normalen Arthrogram des Schultergelenks ist übrigens, dass die Umschlagfalte der Gelenkkapsel in der Axille so geräumig ist, und hier eine grosse Aufblähung bildet, den axillaren Gelenkbeutel, der ein Reservoir der eventuell vermehrten Gelenkflüssigkeit sein kann. Die zwei Blätter des Beutels liegen normal durch einen kapillaren Spalt getrennt, sobald man aber Luft oder Kontrast injiziert, erweitert er sich. Seine volle Grösse tritt bei entspanntem leicht abduziertem Arm in mittlerer Rotationsstellung am besten hervor. Macht

man einen Abguss der Gelenkhöhle Fig. 5 a—b. wird man indessen wahrnehmen, dass diese tütenformige Erweiterung der Umschlagfalte nicht nur auf die Axille beschränkt ist, sondern sich auch hinaufstreckt, an der Mitte des Gelenks vorbei. Nach Injektion von 5—6 cc. Kontrast sieht man übrigens im Gelenkspalt einen 1—2 mm. breiten, ganz regelmässigen Kontraststreifen, von der Axille bis an den Collum Anathomicum, zuerst zwischen den Knorpeln des Caput und der Gelenkpfanne, dann zwischen denjenigen des Caput und der Gelenkkapsel. Fig. 6. Am oberen Ende der Cavitas glenoidalis wird eine kleine Ausbuchtung gefüllt. Sie entspricht dem Ausgangspunkt der Bicepssehne. Mit dem Patienten in 45 Grad schräger Stellung sitzend und indem man den Oberarm nach aussen rotiert, sieht man das Hauptsächlichste des Kontrasts um die Knochenkugel gelagert, während eine dünne Schicht vom Kontrast dieselbe bedeckt. Auf der Stelle, wo die Bicepssehne ausspringt, kommt nun ein elipsenförmiges Loch im Kontrast zum Vorschein. Von hier aus geht ein lateral konveks bogenförmige helles Band über dem Knochenknopf und weiter zwischen Tuberculi humeri entlang, dem Laufe der Sehne entsprechend. Fig. 7. Der Aussprung der Bicepssehne tritt besonders schön hervor, wo man Luft und Perabrodil benutzt. Fig. 8. Die Sehne und ihr Aussprung sind von einem schmalen Streifen Kontrast umgeben, der sie gegen die Umgebungen scharf abzeichnet. Ruptur der Bicepssehne ist in unserem Material indessen nicht vorgekommen. In dieser Stellung kann man auch in dem Teil der Subscapularissehne, die von Bursa subacromialis nicht bedeckt wird, Ruptur erzielen. Gewöhnlich erreicht man auch die Füllung der Bursa subscapularis, einer 1—2 cm. langen Ausbuchtung der Kapsel vor der Gelenkpfanne, und des Collum scapula, der Kontrastschatten aber wird am oftesten von diesem gedeckt.

Diagnostizierte und operierte Fälle.

Von den 15 diagnostizierten und operierten Fälle werden einige besprochen.

No. 1. 63jähriger Fischer. Vier Wochen vor der Ankunft Verletzung der rechten Schulter. Arthrographie des Schultergelenks. Fig. 9. Nach Injektion von 10 cc. Luft und 6 cc. Perabrodil sieht man normale Dilatation des axillaren Gelenkbeutels. Die Luft füllt einen birnenförmigen, kontrastgefütterten Raum über dem Tuberculi humeri. Vom medialen Ende dieses Raums erstreckt sich ein kontrastgesättigter, drähtchenartiger Streifen unter dem Acromion bis ans Acromioclaviculargelenk. Bei der am folgende Tage stattgefundenen Operation fand man eine 5 cm. lange Ruptur durch die Supra und Infraspinatussehne, mit einem peripheren Sehnenstummel von 1 cm. Suturatio tend.

No. 2. 45jähriger Fischer. 3 Monate vor seinem Eintreffen hat er die linke Schulter durch einen 3 m. hohen Fall verletzt. Arthrographie: Es wurde 6 cc. Perabrodil injiziert. Fig. 10. Der axillare Gelenkbeutel ist wenig ausgespannt. Ein $^1/_2$ cm. breiter, gut kon-

trastgesättigter Rand, nach beiden Seiten zugespitzt, erstreckt sich schalenförmig über den oberen Ende des Humerus entlang, vom Acromion bis an Collum chirurgicum Humeri. Man kann ihn als einen schmalen, kontrastgesättigten Streifen unter dem Acromion ans Acromioclaviculargelenk weitergehen sehen. Nach vorne sieht man die Füllung des distalen Endes der Bicepssehnenscheide. Am nächsten Tage Operation. Man fand eine 5—6 cm. lange Ruptur durch die Sehne des Musc. subscapularis und in die Sehne des Musc. Supraspinatus hineingehen, mit einem peripheren Sehnenstummel von 1 cm. Suturatio tend.

No. 3. 57jähriger Fischer. Anderthalb Monate vor der Ankunft im Krankenhaus fiel er auf dem Eise und beschädigte sich die linke Schulter. Arthrographie. Fig. 11. Nach Injektion von 10 cc. Luft sieht man einen normalen ausgespannten axillaren Gelenkbeutel. Über dem oberen Ende des Humerus tritt gleich die Füllung eines bootförmigen, 1 cm. breiten Raums ein, der sich vom lat. Ende des Acromion bis an den Collum chirurgicum ausdehnt. Bei der Operation fand man eine Ruptur der Supraspinatussehne mit unbedeutenden peripheren Stummel. Suturatio tend.

No. 4. 58jährige Hausfrau. Sechs Wochen vor der Ankunft waren durch verkerhtes, schweres Heben nachher starke Schmerzen in der rechten Schulter aufgetreten. Arthrographie. Fig. 12. Injektion von 10 cc. Luft. Gelenkbeutel normal. Die Luft füllt sogleich einen gut 1 cm. breiten Raum, der sich von dem lateralen Rand des Acromion bis an eine 1 cm. breite Entfernung distal des Tuberc. majus, erstreckt. Er ist durch eine dünne Scheidewand zweifach geteilt. Bei der Operation fand sich eine Ruptur der Supraspinatussehne, ohne peripheren Stummel. Suturatio tend.

No. 5. 49jährige Frau. Gerade vor der Ankunft Luxatio humeri dexter. Bei der Untersuchung findet sich Caput humeri vorwärts hinunter luxiert. Arthrographie. Gerade nach der Reposition wurde Arthrographie vorgenommen. Nach Injektion von 10 cc. Luft und 6 cc. Perabrodil sieht man die Luft sogleich vorwärts hinunter unter den Muskeln verschwinden, die Gelenkkavität wird fast nicht gefüllt. Nach Injektion mit Perabrodil sieht man auch dieses durch den vermuteten Spalt verschwinden. Der Kontrast in der Gelenkhöhle ist spärlich und entweicht leichter durch den Kapselspalt als er wahrscheinlich durch einen möglichen Spalt in der Sehnenmanschette hätte hindurch gedrückt werden können.

Zwei Wochen nach der Verletzung erneuerte Arthrographie des rechten Schultergelenks. Injektion von 10 cc. Luft und 6 cc. Perabrodil. Gelenkbeutel normal, und kein Zeichen zum Spalt in der Kapsel nach unten. Über dem oberen Teil des Gelenks wird ein bootförmiger Raum, etwa 1 cm. breit, mit Kontrast gefüllt. Bei der Operation am Tage darauf fand sich eine Ruptur der Supraspinatussehne mit unbedeutendem peripherem Stummelchen. Suturatio tend.

No. 6. 52jährige Frau. Vor 6 Wochen die linke Schulter verletzt. Arthrographie. Fig. 13. Nach Injektion von 6 cc. Perabrodil sieht man, dass der Kontrast sogleich einen schälenförmigen, etwa 1 cm. breiten Raum über dem oberen Ende des Humerus füllt. Bei der Operation am folgenden Tag fand sich Ruptur der Supraspinatussehne ohne peripheren Stummel. Suturatio tend.

Diagnostizierte nicht operierte Fälle.

Von den 13 diagnostizierten noch nicht operierten Fällen werden nur einige besprochen. In allen Fällen fand sich die Kommunikation zwischen

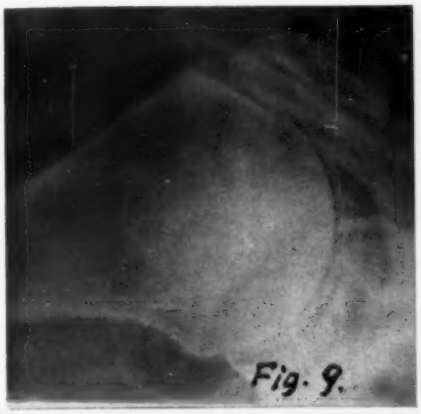

Fig. 9—14. Bursa Subacromialis. 9. mit Luft gefüllt, und mit kontrastgefütterte Ränder. 11—12. Nur mit Luft gefüllt. 10, 13, 14. Mit schattengebendem Kontrast gefüllt.

Fig. 15—17. 15—16. Inkomplette Rupturen. 17. Abriss des Tuberculum majus. Er ist 1 cm. nach oben gezogen und dort angewachsen.

der Gelenkhöhle und einem mehr oder weniger bottförmigen Raum über dem oberen Ende des Humerus.

No. 7. 66jähriger Fischer. Vor drei Jahren Luxatio humeri dexter. Arthrographie des rechten Schultergelenks. Injektion von 10 cc. Luft und 6 cc. Perabrodil. Gelenkbeutel normal. Sogleich tritt die Füllung einer bootförmigen, etwa 1 cm. breiten Partie über den Tuberculi ein. Man sieht auch Kontrastfüllung des Spaltes des Acromioclaviculargelenks. Beide Tuberculi sind geebnet und etwas kalkatrophisch. Man nimmt an, dass der kontrastgefüllte Raum über den Tuberculi die Bursa subacromialis ist.

No. 8. 63jähriger Fischer. Vor zwei Jahren direkten Fall an der rechten Schulter. Arthrographie. Fig. 14. Injektion von 6 cc. Perabrodil. Der Kontrast füllt einen unregelmässigen Raum, der sich von einem Punkt, 1 cm. medial des Acromioclaviculargelenks, lateral bis an den distalen Rand der Tuberculi ausdehnt. Im Kontrast sieht man kleine fadenförmige Aufhellungen. Caput humeri ist nach oben subluxiert. Man vermutet, dass es die kontrastgefüllte Bursa subacromialis ist, und dass die fadenförmigen Aufhellungen den Boden der zerrissenen Bursa erkenntlich machen.

Schulterschaden mit inkompletter Ruptur der Sehnenmanschette.

Die inkompletten Rupturen entstehen dadurch, dass kleine Risse in der Sehnenmanschette gebildet werden. Sie sind doch nicht so gross, dass sie durch diese hindurch gehen, so dass Kommunikation zwischen der Gelenkhöhle und der Bursa subacromialis entsteht.

Wenn die inkomplette Ruptur and der unteren Seite der Sehnenmanschette liegt, oder mit der Gelenkhöhle kommuniziert, wird sie bei der Arthrographie zum Vorschein kommen.

Am häufigsten gehen die Spalte and den Sehnenfasern entlang, und erscheinen dort auf dem Arthrogram als kontrastgesättigte Streifen, die mit dem Gelenkspalt parallel laufen, oder die gegen die Be-

festigung der Gelenkkapsel am Collum anathomicum konvergieren können. Fig. 15.

Wenn der Riss querläuft, treten mehr oder weniger unregelmässige, zapfenförmige, kontrastgesättigte Vorsprünge hervor vom Gelenkspalt in die Sehnenmanschette hinauf. Fig. 16.

Bisweilen können auch mehrere kleine Risse vorliegen, so dass die obere Grenzwand der Gelenkhöhle gegen die untere Seite der Sehnenmanschetten wie ein gefranztes Band aussehen kann.

Liegt neben der inkompletten Ruptur eine Fractur des Tuberculum majus vor, kann das Bild manigfaltiger erscheinen und oft eine Mischung aufweisen.

Von den 10 Fällen mit inkompletter Ruptur werden folgende erwähnt.

No. 9. 58jährige Frau. Luxatio humeri vor drei Wochen. Arthrographie. Nach Injektion von 6 cc. Perabrodil sieht man, dass die Sehnenmanschette distalwärts der Supraspinatussehne entsprechend 2 cm. lang medial des Collum anathomicum uneben begrenzt und zerfranzt ist. Sonst normaler Gelenkspalt und axillarer Gelenkbeutel.

No. 10. 27jähriger Soldat. Hatte vor zwei Monaten durch direkten Stoss gegen die Schulterregion die linke Schulter verletzt.

Arthrographie. Fig. 15. Nach Injektion von 10 cc. Luft und 6 cc. Perabrodil sieht man, dass die Oberfläche des Tuberc. majus ein wenig rauh ist, mit stecknadelknopfgrossen Aufhellungen im Knochen gerade unter der Oberfläche. Über dem vorderen Rand des Tuberc. majus und den angrenzenden Teilen des Collum anathomicum, sieht man mehrere, gut 1 cm. lange, parallellaufende Kontraststreifen der Supraspinatussehne entsprechend ausserhalb der Gelenkhöhle. Gleich an der Sehnenbefestigung sind ein paar grützgrosse, luftgefüllte Räume, deren Wände mit Kontrast gefüttert sind. Übrigens normale Gelenkhöhle und axillaren Gelenkbeutel, ohne Kommunikation an Bursa subacromialis.

No. 11. 65jähriger Transportarbeiter. Beschädigte vor anderthalb Jahren die linke Schulter.

Arthrographie. Fig. 16. Nach Injektion von 10 cc. Luft und 6 cc. Perabrodil sieht man der Befestigung der Gelenkkapsel und der Supraspinatussehne am Collum anathomicum entsprechend, dass der Kontrast in der Gelenkhöhle etwa 5 mm. in die weichen Teile knospenförmig hineingeht. Ebenfalls wird ein 3 cm. langer, ganz schmaler Spalt im Verlauf der Sehne mit Kontrast gefüllt. Gelenkspalt und axillarer Gelenkbeutel sonst normal.

Arthrographie nach Luxatio humeri und Fract. Tuberc. majoris.

Bei no. 12 tritt deutlich hervor dass bei Luxatio humeri mit dem Zerreissen des Tuberc. majus die Sehne hält, während der Tubercel abgerissen ist, und dass die Sehne den Tuberc. majus mitgezogen hatt, so dass er 1. cm. zu weit nach oben angewachsen ist. Dies muss wahrscheinlich auch der Fall sein, wo nur ein Abreissen des Tuberc. majus ohne Luxatio humeri vorliegt. Es sind die Supra und Infraspinatussehnen, die dem Trauma ausgesetzt worden sind, und dadurch dass die Sehnen gehalten haben, haben sie den Tuberc. majus mitgezogen. Ist die Sehne schwach, zerreisst

sie, wie bei Älteren mit degenerativen Änderungen. Ist die Sehne stark, stellt man oft das Abreissen des Tuberc. majus fest. An diesem Material sieht man aber doch, dass bei pat. von 60 und 74 jahren die Sehne sogar halten kann, der Tuberc. majus aber zerreisst, (No. 15 und 16) während die Sehne im Alter von 48 und 66 zerreisst (No. 5 und 7). Man sieht auch, dass man bei Schulterluxationen nur eine inkomplette Ruptur erhalten kann, No. 9. Bei Abreissfractur des Tuberc. majus hätte man auch erwarten sollen, mit der Bursa subacromialis Kommunikation zu erhalten. Da dies so selten vorgekommen ist, nur im Falle No. 14, kommt es wahrscheinlich daher, dass die Arthrographie eine Weile nach der Verletzung vorgenommen ist. Die Fractur war in Begriffe zu heilen, und eine eventuelle Verbindung zwischen der Bursa und dem Gelenk damit geschlossen. Wie aus No. 5 hervorgeht, wird es sich oft nicht lohnen, gleich nach der Reposition einer reinen Luxation, die Arthrographie vorzunehmen, zu dem Zweck, eine Ruptur der Sehnenmanschette entdecken zu können, da der Kontrast durch den Kapselriss entweicht. Man muss die Arthrographie vornehmen, nach dem der Kapselriss abwärts und vorwärts sich geschlossen hat, oder ausgeheilt ist. Die Ruptur der Sehnenmanschette nach oben bleibt offen stehen, da der zentrale Stummel sich zurückzieht. Wie schnell der Spalt zugeklebt wird, ersieht man aus No. 13 und 17, wo die Arthrographie einen bis zwei Tage nach der Reposition vorgenommen ist, ohne ein Anzeichen, dass der Kontrast durch diesen entweicht.

Von den 12 Fällen mit Arthrographie nach Luxatio humeri oder Fract. Tuberc. majoris werden folgende erwähnt.

No. 12. Luxatio humeri c. fract. Tuberc. majoris sin. 54jährige Frau. Arthrographie vom linken Schultergelenk 3 Wochen nach der Beschädigung. Fig. 17. Tuberc. majus sieht man abgerissen. Er ist 1 cm. nach oben gezogen, so dass er die proximale Gelenkfläche des Caput humeri in dieser Länge überragt. In dieser Stellung ist er angewachsen. Nach Injektion von 6 cc. Perabrodil beobachtet man, dass der Kontrast längs der Gelenkfläche unter der prominierenden Partie den Raum ausfüllt.

No. 13. Luxatio humeri c. fract. Tuberc. majoris dext. 48jähriger Transportarbeiter. Arthrographie zwei Tage nach der Verletzung. Nach Injektion von 10 cc. Luft und 6 cc. Perabrodil sieht man sonst normalen axillaren Gelenkbeutel und Gelenkspalt, ohne Kommunikation an Bursa subacromialis.

No. 14. Fractura Tuberc. majoris humeri sin. c. fract. colli chirurgici humeri. 49jährige Frau. Arthrographie am Tage nach der Beschädigung. Injektion von 10 cc. Luft und 6 cc. Perabrodil. Normaler axillarer Gelenkbeutel. Man sieht auch einen gut gesättigten, 3 mm. breiten Kontraststreifen, der sich über dem abgerissenen Tuberc. majus wölbt, bis an den lateralen Rand des acromion reichend. Man vermutet, dass es Bursa subacromialis ist, und dass also zwischen dieser und der Gelenkhöhle Kommunikation ist. Zwei Monate nach der Verletzung war die Fractur in guter Stellung ausgeheilt. Bei Arthrographie kann man nun normale Gelenkhöhle und axillaren Gelenkbeutel sehen, ohne Kommunikation an der Bursa subacromialis.

Man sieht in diesem Fall, dass in und mit einer Abreissung des Tuberc. majus eine Kommunikation zwischen Gelenkhöhle und Bursa zustande gekommen ist. Nachdem der Tubercel wieder ausgeheilt ist, ist die Kommunikation aufgehoben. Die Sehnenmanschette hat also stand gehalten. Der abgerissene Tuberc. majus hat auch den Boden der Bursa mitgerissen, und die Verbindung zwischen Gelenkhöhle und Bursa ist durch den Fracturspalt entstanden.

No. 15. Luxatio humeri o. fract. Tuberc. majoris dext. 74jährige Frau. Arthrographie zwei Monate nach der Beschädigung. Injektion von 5 cc. Perabrodil. Der Kontrastschatten in dem Gelenkspalt gegen Cavitas glenoidalis ist ein wenig uneben. Der axillare Gelenkbeutel wenig ausgespannt. Keine Kommunikation an Bursa subacromialis.

No. 16. Luxatio humeri c. fract. Tuberc. majoris sin. 60jährige Frau. Arthrographie 6 Wochen nach der Beschädigung. Nach der Injektion von 5 cc. Perabrodil sieht man den axillaren Gelenkbeutel beinahe an einander geklebt, aber den Gelenkspalt sonst normal.

No. 17. Luxatio humeri dext. 35jähriger Bauer. Arthrographie am Tage nach der Verletzung, 10 cc. Luft und 6 cc. Perabrodil. Der Kontrast zeigt keine Neigung, durch den Spalt zu entweichen, den Caput humeri während der Luxation hätte bilden können. Gelenkbeutel und Gelenkspalt normal.

Von den übrigen Patienten mit Arthrographie des Schultergelenks ohne Zeichen zur Ruptur, waren 11 mit Tendinitis calcarea, 3 mit Luxatio acromioclavicularis, 5 mit Fract. clavicula am lateralen Ende, und 18 andere Schulterbeschädigungen. Mehrere von den Fällen mit positiven Röntgenfund sind, wie aus der Kasuistik hervorgeht, noch nicht operativ verifiziert. Die Röntgenbilder sind doch so typisch, dass man sich erlaubt hat zu behaupten, dass zwischen der Bursa und dem Gelenk Kommunikation ist. Wenn so viele davon nicht operiert worden sind, ist die Ursache die, dass mehrere davon so alte Rupturen gehabt haben, dass man am Nutzen einer Operation gezweifelt hat. Mehrere waren auch Pat. der Reichsversicherung die lieber ihre Zinsen ziehen wollten als sich einer Operation aussetzen zu lassen.

An 6 Operierten ist nach der Operation Arthrographie vorgenommen worden. In 4 Fällen fand sich normale Gelenkhöhle, ohne Kommunikation an Bursa subacromialis. Bei zwei von ihnen aber fand sich Kommunikation an der Bursa. Dass man eine Kommunikation zwischen Gelenkhöhle und der Bursa nach der Operation nachweisen kann, braucht nicht zu bedeuten, dass die Ruptur wie früher ist, da ein kleiner Riss nach einer ausgefaserten Sutur genügt um Verbindung zu bilden.

Die Ruptur der Sehnenmanschette des Schultergelenks soll nach einem Alter von 40 Jahren vorkommen. Dass sie aber auch in jüngerem Alter eintreten kann ersieht man aus No. 10, einem 27jährigen Mann mit incompleter Ruptur.

Bei Arthrographie des Schultergelenks hat man das Verhalten des axillaren Gelenkbeutels genau beachtet. Es ergibt sich nämlich, dass

sich dieser in vielen Fällen sehr wenig dilatiert findet, dann und wann ist er so zu sagen zusammengeklebt oder zusammengeschrumpft. Seine normale Form sieht man auf Fig. 6 und 12, als eine blasen- oder tütenformige Bildung. Man sieht, dass das Einschrumpfen nach Schulterschäden mit dauernder Immobilisation vorkommt, und auch nach Schulterschäden, wo der Arm schmerzt und deswegen zu lange in Ruhe in abduzierter Stellung bleibt. Wo die Beweglichkeit im Schultergelenk normal war, wurde der axillare Gelenkbeutel auch immer normal befunden, wenn auch die Bewegung von grossen Schmerzen begleitet waren. Bei Schrumpfung der Kapsel fand man immer beschränkte Beweglichkeit von Schmerzen begleitet, und oft gestörten humeroscapularen Rythmus. Bei Ruptur der Supraspinatussehne ist es von Bedeutung, nachweisen zu können, ob es gleichzeitig röntgenologisch nachweisbare Schrumpfung der Kapsel gibt, da man in solchen Fällen nicht so gute Erfolge nach einer eventuellen Operation erwarten kann. Es kann möglich sein, dass diese Schrumpfung der Kapsel der röntgenologische Ausdruck für CODMANS »Frozen Shoulder» ist.

Zuletzt möchte ich gerne meinem Chef Dr. HJORT danken, für sein grosses Interesse und seine inspirierende Leitung während des Studiums der Schulterbeschädigungen, und der Ausarbeitung dieser Arbeit.

ZUSAMMENFASSUNG

In der vorliegende Arbeit wurden im besonderen die Arthrographie des Schultergelenks mit Rücksicht auf die Ruptur der Sehnenaponeurose des Gelenks, und die anathomischen und pathologisch anathomischen Umstände bei der Untersuchung besprochen. Die Untersuchung beabsichtigt die zwischen der Gelenkhöhle und der Bursa subacromialis in und mit der Ruptur sich bildende Kommunikation nachzuweisen. Punktion des Schultergelenks wurde von vorne ausserhalb des Gebiets der Bursa subacromialis ausgeführt mit Injektion von Perabrodil, Luft oder einer Mischung von diesen beiden. Die Kontrastmittel verteilen sich dabei zwischen der Gelenkhöhle und der Bursa, wenn Ruptur mit Kommunikation zwischen den zwei Kavitäten vorliegt. Die Arbeit gründet sich auf dem Studium der normalen und pathologischen Verhältnissen bei 42 Sektionspräparaten, und 87 Patienten, die nach Schultertrauma untersucht worden.

SUMMARY

In this paper arthrography of the shoulder joint with particular reference to rupture of the tendon-aponeurosis of the joint is reported. The anatomical and pathological conditions at the examination are discussed. The examination is performed for the purpose of proving the communication between the articular joint and the bursa subacromialis developing within and with the rupture. Punctuation of the shoulder joint was performed frontally outside of the area of the bursa subacromialis with the help of perabrodil, air or of a mixture of both substances. If rupture with communication between the two articular cavities is present then the contrast media will fill the space between the articular joint and the bursa. The paper is based on the study of 42 post mortem preparations and of 87 individuals, who had been examined for trauma of the shoulder.

RÉSUMÉ

Le présent travail est consacré en particulier à l'arthrographie de l'épaule, aux ruptures de l'aponévrose tendineuse de cette jointure, et aux constatations anatomiques et anatomo-pathologiques faites lors de l'examen. Cet examen vise à démontrer la communication qui s'établit entre la cavité articulaire et la bourse sous-acromiale du fait de la rupture. On ponctionna l'articulation scapulo-humérale en avant, en dehors de l'aire de la bourse sous-acromiale, et on injecta du Perabrodil, de l'air, ou un mélange des deux. Les substances à contraste se répartissent alors entre la cavité articulaire et la bourse s'il existe une rupture avec communication entre les deux cavités. Le travail est basé sur l'état normal et pathologique de 42 préparations anatomiques, et sur l'étude de 87 malades qui furent examinés après un traumatisme de l'épaule.

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EXPERIMENTAL INVESTIGATIONS OF THE EFFECTS OF ROENTGEN-RAYS ON THE EPITHELIUM OF THE CRYSTALLINE LENS[1]

by

Erik Poppe

Numerous cases of cataract in man after therapeutic roentgen or radium irradiation of the eye or it's surroundings have been described. Opacities in the lens appear after a latent period of at least one year, as a rule 2—3 and even 5 years and more after irradiation. MILNER states the shortest latent period reported to be $9^1/_2$ months, the longest 12 years.

Roentgen cataract in man usually has a characteristic morphologic appearance (ROHRSCHNEIDER). The following description is considered typical and is the one usually presented when the cataract is first observed: Opacities are most pronounced in the axial region of the posterior cortex. They are situated immediately in front of the posterior capsule, and consist of numerous vacuoles and streaks, forming a dish- or saucer-shaped opacity, as a rule densest towards the perifery. This disciform subcapsular opacity in the posterior cortex has a sharp line of demarcation anteriorly, towards the remaining clear part of the cortex. Beneath the anterior lens capsule diffuse vacuoles and striæ are seen, but less pronounced than posteriorly. The remaining part of the cortex and the lens nucleus are usually clear. The appearance is so characteristic that roentgen cataract should be diagnosed in clinical examination (ROHRSCHNEIDER). The fact that roentgen cataract as a rule shows to a certain extent a characteristic clinical picture may in certain cases be forensically significant. Large roentgen doses produce after a latent period of about 1 year a progressive cataract, which from the described »typical» appearance develops into total cataract of the lens, without characteristic features.

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The reason for the long latent period before the cataract becomes clinically observable has not been entirely cleared up. Agreement has not yet been reached as to whether the cataract develops from the direct effect of radiation on the lens (ROHRSCHNEIDER, LEINFELDER and KERR, REESE), or from disturbance in nutrition conditions through the effect on iris and corpus ciliare (AULAMO, MARTIN, MILNER, WÖLFFLIN).

In earlier days comparatively few and unsatisfactory histologic lens studies have been carried out after irradiation. Many research workers have been content with clinical examinations, including slit lamp examinations, in their experimental work. The crystalline lens is a purely epithelial organ with slow metabolic processes, and offers in many ways an ideal subject for the experimental study of purely epithelial changes after irradiation. Histologic examination of the irradiated lens carried out with adequate technique, partly with special preparations from the lens, and partly with preparations from the whole of the bulbus with the lens in situ, may therefore give interesting results also as far as radiation biology is concerned. Post-irradiative histologic examination may also give clues to the understanding of the genesis of the roentgen cataract. If this factor were known an explanation of the long latent period from irradiation until the cataract becomes clinically manifest would probably also be obtained.

For the histologic examinations of the lens I have in my experimental investigations with rabbits in addition to sectional preparations also made total lens epithelial preparations for closer examination. This method has formerly rarely been mentioned. Concerning the rabbit lens I have succeeded in finding a couple of works only on this subject. (ALPHONSE, 1909, OKUSAWA 1933), and descriptions of the appearance of the total preparations are incomplete. For this reason I have considered it necessary to insert a section about my own experiences of normal-anatomical lens epithelial examinations in total preparations compared with sectional preparations from normal non-irradiated animals. I have worked out a special technique for making total lens epithelial preparations which has proved suitable:

In the enucleated bulbus an incision is made behind the equator through the sclera, choroid and retina, and a large posterior »cap» is removed, leaving the posterior surface of the crystalline lens exposed. With a pair of small pointed and bent scissors the zonula Zinni is cut as near as possible to the lens equator. The lens thus loosened is deposited in a Petri cup, the posterior pole upwards. With a knife-needle a cross incision through the posterior cortex into the nucleus lentis is made, the cortex is folded aside leaving the nucleus lentis exposed. The nucleus is then loosened from the anterior cortex by means of a bent and very fine pair of forceps and removed. The opened posterior cortex, anterior cortex, epithelium and lens capsule are now left in the cup. A knife-needle is inserted between the fibre bundles and these are carefully peeled from the epithelium. The difficulty consists in striking the correct layer; with some practice it is easily done however.

Finally a fine membrane, consisting of epithelium and anterior capsule remains in the cup. With a fine spatula the preparation is placed on a polished wooden slide. Because of the curvature of the anterior lens surface some small radial incisions have to be made in order to get the preparation properly stretched out. When spread, the shape is circular. Finally the preparation is fastened to the wooden slide with fine wooden sticks into holes specially prepared beforehand. Because of later treatment the epithelium must lie facing upwards and the lens capsule down towards the wooden slide. The stretched preparation is fixed in Stieves solution 1—2 hours. Rinced in water. Alcohol 70 % for 2—3 hours. The preparation is then removed from the wooden slide and pass through alcohol 96 % and absolute alcohol into xylol. Filtered hematoxylin 1/2 hour. Rinced in water 1/4 hour. Alcoholic eosin a few seconds. Dried and placed on glass slide. Mounted in Canada balsam. The preparation has a thickness corresponding to the anterior lens capsule + epithelium, that is in rabbits about 40 μ + 5 μ = 45 μ, and gives practically ideal conditions for study of lens epithelium both in normal and in pathologic conditions.

As material for the normal-anatomical examinations 20 adult rabbits have been used. These animals have also served as controls for the experimental roentgen examinations.

In all total lens epithelial preparations, in normal preparations from non-irradiated animals as in preparations from irradiated animals I have noticed a peculiar condition, which I have never seen described. Two cellular types of distinctly different appearance may be observed. First a type which I propose to call the »ordinary» is noticed, the appearance of which, as well known, differs centrally and peripherally in the preparation, the centrally situated cells being polyedrous, and the peripheral ones more oval-shaped. (Figs. 1 and 2.) Between these cells however, are seen cells, triangular or star-shaped, in which cytoplasm is scarce but is fibrillar in structure, both cytoplasm and nucleus are considerably darker stained than the ordinary epithelial cells. (Fig. 3.) For lack of a better name I have chosen to call these cells »starshaped» epithelial cells, a term alluding exclusively to their shape.

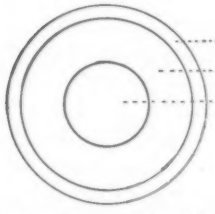

Diagram of the differentiation of total preparation in 3 zones.

Both starshaped and ordinary epithelial cells react alike to silver staining.

To exclude the possibility of these starshaped cells representing artificial products of fixation, I have besides Stieve's solution also used Susa's solution and Bouins fluid for fixation of some preparations. These preparations show the same picture of two different cellular types. Further, the same cellular forms are also found in sectional lens preparations (Fig. 4.) These have been fixed in Szent Györgyis fluid and treated according to a technique totally different to the one used in making total lens epithelial preparations. I therefore believe myself justified in claiming

that the starshaped lensepithelial cells do not represent artificial products, which also seems improbable because of their appearance. In examination of total preparations which, as already mentioned, have an approximately circular shape, it may further be noticed that distribution of the two cellular types is not uniform in the various parts of the preparation. There may be differentiated, roughly speaking, three zones in the total preparation. In each zone the appearance of lens epithelium and distribution of the cellular forms differ. (Diagram.)

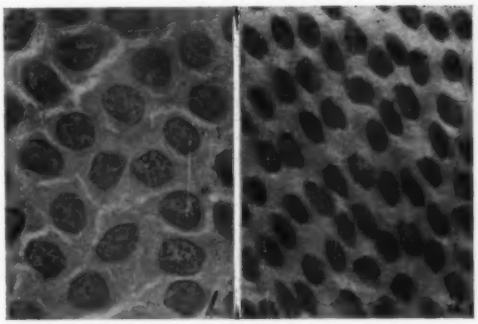

Fig. 1. Total lens epithelial preparation from unirradiated rabbit. Central zone. × 600.

Fig. 2. Total lens epithelial preparation from unirradiated rabbit. Peripheral zone. × 600.

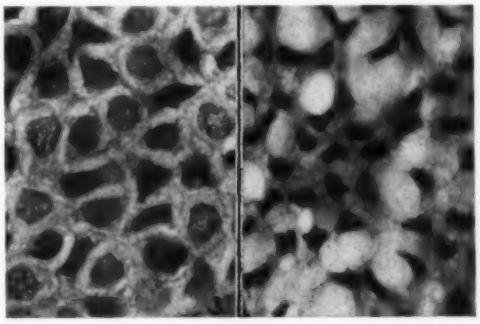

Fig. 3. Total lens epithelial preparation from unirradiated rabbit. Middle zone. The two different cellular forms. × 600.

Fig. 4. Sectional lens preparation from unirradiated rabbit. Equatorial region. The starshaped cells. × 600.

1) Peripherally in the preparation corresponding to the equatorial region a narrow zone is seen showing a homogenous appearance. The nuclei are oval or round-oval, rich in chromatin. Some nuclei are seen to be somewhat richer in chromatin and more darkly stained than the surroundings, otherwise there is no difference in cellular appearance in this part of the preparation. This is the fibre forming epithelium (Fig. 2).

2) The middle zone is wider, with, as already mentioned, two cellular types of distinctly differing appearance. Most of the cells are ordinary lens epithelial cells, polyedrous, with large transparent round nuclei and rich amounts of cytoplasm. The nuclei are not so rich in chromatin as in the peripheral zone. Between these cells diffuse starshaped triangular lens epithelial cells are seen, the nuclei more darkly stained and the scantier cytoplasm showing the marked fibrillar structure (Fig. 3).

3) Centrally there is a zone with uniform cells. The cells have the same appearance as ordinary lens epithelial cells from the middle zone,

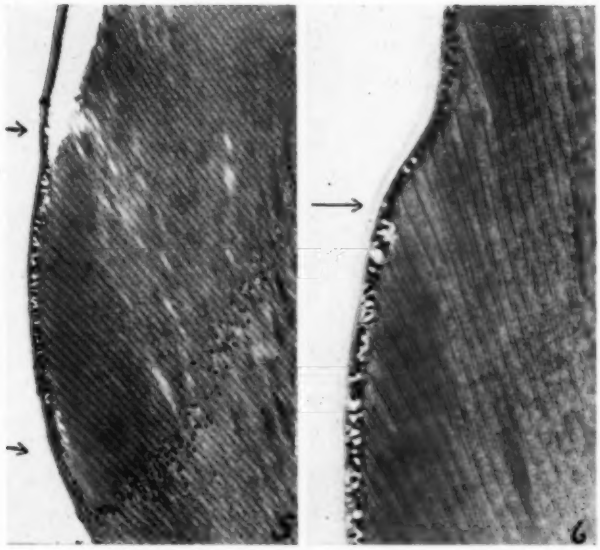

Fig. 5. Sectional lens preparation from unirradiated rabbit. Differentiation between 3 lensepithelial zones. The starshaped cells are seen in the region where the zonula fibres are attached (Between the arrows). × 75.

Fig. 6. Sectional lens preparation from unirradiated rabbit. Transition between middle and central zone (see arrow). × 150.

they are polyedrous, have large clear round nuclei and are rich in cytoplasm. (Fig. 1.) In this zone starshaped cells are thus practically not seen. I want to emphasise that transition between zones is nowhere distinct.

The number of starshaped cells decrease gradually towards the centre in such a way that transition becomes vague. One also gets the impression that the starshaped cells gradually and almost imperceptibly pass into or take on the shape of the two other cellular types found peripherally and centrally, which adds to the impression of the absence of any actual border between the zones. The middle zone occupies about 3/4 of the total preparation, I have been unable to give more exact informations about the relative size of the zones. The described differentiation between 3 lens epithelial zones is also recognised in sectional preparations (Fig. 5).

Based on my own examinations I have tried to clarify the nature of starshaped cells, but without success. Generally speaking one may say that the lens epithelium has two different functions, partly a covering and protective one, possibly connected with lens nutrition, partly a lens fibre forming one. In accordance with the various functions the appearance of the epithelium differs peripherally and centrally, as is generally known, and which fact I have already mentioned.

Concerning the starshaped cells, which are seen mostly in the wide middle zone, they are possibly a kind of resting lens epithelial cells, centrally showing transition into covering epithelium, and peripherally into lens fibre forming epithelium.

I have attempted to form an idea of the number and distribution of mitoses in the lens epithelium by studying the whole of the total preparation. This has been done in five total preparations. It appears that the number of mitoses amounts to 0—10 in every preparation, and further that they usually occur in the peripheral part of the middle zone, that is, in the region immediately anterior to the equator, as has been described in text-books. Mitoses are seen in ordinary lens epithelial cells only, I have been unable to find any starshaped cell in mitosis. Theoretically however, other possibilities for explaining the nature of the starshaped cells remain. Studying a sectional preparation from a rabbit lens the starshaped cells seen in total preparations will be recognised in the first meridional sections cut through the eqatorial region or immediately inside this. (Fig. 4.) Further it will be noticed that these cells are present in the very lens region in which zonula Zinni is attached to the capsule. (Figs 5 and 6.) Another interesting circumstance is the normal presence of large round clear parts in the cytoplasm of the starshaped cells. (Fig. 4.) It may therefore be suspected that these cells take part in forming a kind of vascular system, and that the cells thus are important in lens nutrition. Circulation in these parts will be furthered by movements produced by the zonula fibres. This may explain the presence of starshaped cells in the very region to which the zonula fibres are attached.

For closer study of this problem I have tentatively injected methylene blue dissolved in water into the camera anterior in an effort to fill the above mentioned vacuoles or cavities. The experiments were carried out as follows: Under evipan-sodium anesthesia the cornea was punctured, and, after 5—6 gtts. of chamber fluid had been withdrawn, the same amount of methylene blue solution was injected into the anterior chamber. The animals were killed 29 hours later. From 2 animals total lens epithelial preparations, from a third animal sectional lens preparations were made. There was no evidence of methylene blue in the cells, and the experiment resulted negatively. These preparations showed another very interesting condition however. Abundant cellular disintegration was seen, numerous nuclei consisted of pycnotic fragments only. Large numbers of mitoses were also observed. Mitoses were so numerous that they could not possibly be accurately counted, but one total preparation contained more than 1,000 mitoses (Fig. 7). This may indicate that lens epithelium has considerable regenerative ability after chemical trauma. The possibility cannot be excluded however that the appearance is the result of restricted or

arrested mitotic development (LUDFORD) caused by the toxic effect of methylene blue.

For the roentgen experiments 34 rabbits have been used. The left eye of all animals has been irradiated with the same roentgen dose: 1,500 r. Time: 45 minutes and 46 seconds. For irradiation high-frequency and ray-proof installed Stabilivolt Siemens-Reiniger-Veifa apparatus (Greinacher circuit) was used. The same roentgen tube has been used for all radiations. Otherwise radiation factors have been the same for the whole series: 175 k. v., 4 m. a., filter 0.5 mm. Cu. + 1 mm. Al. + thickness of the tube wall, which the factory has given as equivalent to 2 mm. Al. Half value layer: 1.18 mm. Cu. Homogeneity: 1.46. Skin-target distance: 28 cm. Field: round, diameter 3 cm. corresponding to the tube opening. The dosages were measured on a rabbit cadaver on which an eye had been enucleated and the dosimeter placed in the orbita. The animals were killed after a period of 24 hours to 14 months after irradiation.

The histologic examination of the irradiated lens was carried out partly with total preparations from the lens, partly with preparations from the whole of the bulbus with the lens in situ.

Observation period *24 hours:* In total lens epithelial preparations very small pathologic changes were noticed. In some places cellular nuclei were pycnotic, and also slight evidence of degenerative changes in the cytoplasm, such as vacuolisation and swelling, were seen in a few cells. The changes described were sporadical and peripherally localised in the preparation, near the equatorial region. No mitoses were seen.

Observation period *2 days:* vacuolisation in cytoplasm was more pronounced, and seen chiefly to occur in the starshaped cells, but also in the cytoplasm of the ordinary lens epithelial cells vacuoles were observed. (Fig. 8.)

Observation period *4 days:* The degenerative changes of the lens epithelium appeared to have increased further. In some places the cytoplasm was vacuolised and the nucleus was peripherally situated in the cells, which gave them a resemblance to signet-ring cells (Fig. 9.)

The nuclei were in several places pycnotic and vaguely outlined. In all the preparations examined within 6 days after irradiation mitoses were not seen.

Observation period *6 days:* The first evidence of abnormal cellular division was observed. Lens epithelial mitoses were again seen, in the whole of the total preparation 2 pathologic mitoses with detached chromosome fragments were noticed. Some diffuse cells contained 2 nuclei. These polynuclear cells were rare, and their appearance resembled what has been described as characteristic ordinary lens epithelial cells. One of the nuclei in these binuclear cells was slightly smaller than normal, the second one has a size only a fraction of the first one. (Fig. 10.) The abnormal

cellular division, with the formation of accessory nuclei (»Teilkerne», POLITZER) was in this preparation a regional phenomenon, as accessory nuclei were seen peripherally in the wide middle zone, that is, in the region anterior to the equator. Degenerative changes, such as vacuolisation of cytoplasm and vague nuclear contours were chiefly but not exclusively found in the middle zone.

In the following days the number of accessory nuclei increased, and they were diffusely distributed through large parts of the preparations. Occasionally an accessory nucleus could be seen connected with the main nucleus by a »stem», giving the impression that the small nucleus is about to become detached. (Fig. 14.) There may be 2—3 accessory nuclei in one cell (Fig. 12). Formation of accessory nuclei takes place as already mentioned, from ordinary lens epithelial cells. Accessory nuclei have not been observed in starshaped cells. The degenerative changes with vacuolisation of the cytoplasm were still seen, both in the starshaped and, from about 7 days after irradiation, almost as pronounced in the ordinary lens epithelial cells.

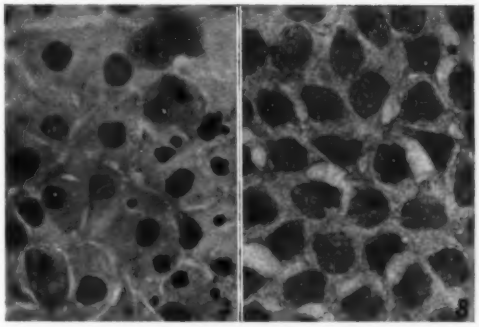

Fig. 7. Total lens epithelial preparation from unirradiated rabbit. Numerous mitoses consequent to intravital injection of methylene blue into camera anterior. × 600.

Fig. 8. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 2 days after irradiation. Vacuolisation of cytoplasm. × 600.

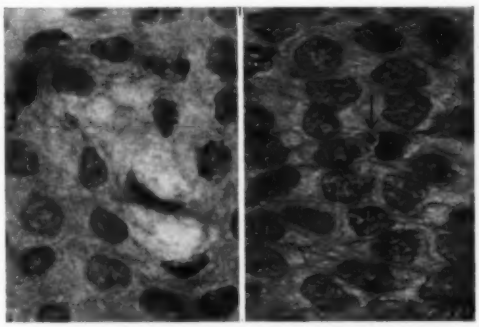

Fig. 9. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 4 days after irradiation. Degenerative changes in cytoplasm. × 600.

Fig. 10. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 6 days after irradiation. Accessory nucleus. (see arrow.) × 600.

Observation period *10 days:* Diffuse cells showed considerable degenerative changes, the nuclei consisting of pycnotic fragments only. Study of the preparation gave the impression that the spaces left by these defects, partly anyway, were occupied by the swelling of the neighbouring cells. In this way the distances between the cellular nuclei vary (Fig. 13),

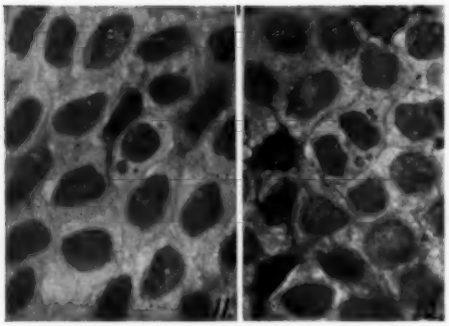

Fig. 11. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 9 days after irradiation. Accessory nuclei. × 600.

Fig. 12. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 10 days after irradiation. Monstrous cell. × 600.

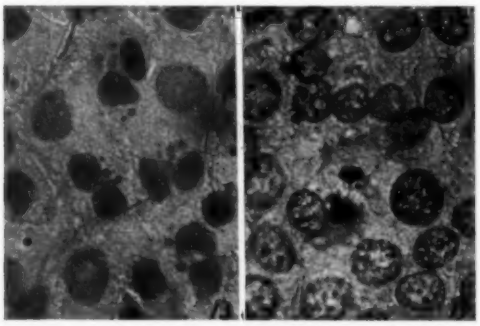

Fig. 13. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 10 days after irradiation. Accessory nuclei. Defects filled by swelling of neighbouring cells. × 600.

Fig. 14. Total lens epithelial preparation. Irradiated. Dose 1,500 r. 2 months after irradiation. Pathologic mitosis with detached chromosome fragment. × 600.

in contrast to the symmetric appearance of the lens epithelium in normal preparations from non-irradiated animals (Fig. 1).

1 month after irradiation the first histologically identifiable lens fibre changes were seen. These occurred in the equatorial region as swollen fibres and vacuolar formation. Some of the pathologic fibres posterior to the equator were nucleus-containing (»pseudoepithelium»).

Observation period *2 months:* The most considerable pathologic changes were still found peripherally in the middle zone, corresponding to the region anterior to the equator. There were numerous accessory nuclei. In this preparation 5 pathologic mitoses with detached chromosome fragments were found (Fig. 14).

Observation period *4 months:* There were considerable variations in nuclear size with formation of monstrous nuclei, up to 2—3 times the normal size. Further there were numerous polynuclear cells containing 2—3 large nuclei and one or more small accessory nuclei (Fig. 15). The number of cells was smaller than normal, and the distance between cells was larger. The degenerative changes seen in former preparations were no longer so pronounced, the degenerative phase appeared to be almost ended. At first about this time, 4 months after irradiation, the cataract had become clinically diagnoseable and appears as numerous opacities peripherally in the posterior cortex.

Observation period *14 months:* the pathologic alterations had increased in intensity and distribution when compared with the preparation examined 4 months after irradiation. There was very pronounced polymorphism of cellular nuclei with formation of monstrous forms. Numerous cells appeared as giant cells, they might contain 2—3 large nuclei and several accessory nuclei. As in the preceeding preparations the changes observed were most strongly pronounced anterior to the equator, but also most cells in the central parts now appeared pathologic. Generally speaking the lens epithelium gave an appearance of absolute disorder, nothing remained of the symmetry in normal preparations from non-irradiated eyes. (Fig. 16, compare fig. 1.) It seems hardly probable that this epithelium would have been able to regain its normal appearance even if the animals had lived longer than 14 months after irradiation.

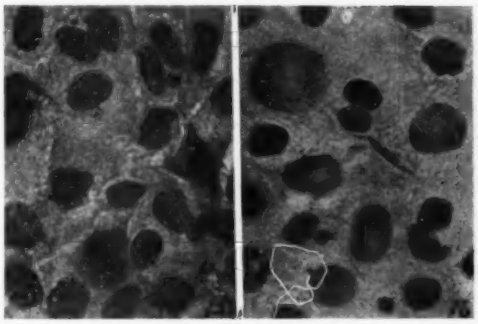

Fig. 15. Total lens epithelial preparation. Irradiated. Dose 1,500 r. 4 months after irration. Nuclear polymorphism. Monstrous cells. × 1,000.

Fig. 16. Total lens epithelial preparation. Irradiated. Dose: 1,500 r. 15 months after irradiation. Nuclear polymorphism. Accessory nuclei. Irregular arrangement of epithelium. × 1,000.

In the uvea, retina and optic nerve no pathologic changes could be observed clinically or histologically after the irradiation, except for slight hyperemia of the vessels the first day after irradiation, and a transitory lowering of the intraocular tension.

Discussion.

24 hours after irradiation slight evidence of degenerative changes is noticed in lens epithelium in the area immediately anterior to the equator. The degenerative changes increase during the following days both in intensity and distribution. Mitoses disappear after irradiation, and reappear only after 6 days. With recurrence of mitosis the first signs of abnormal cellular division with formation of accessory nuclei are observed. Accessory nuclei as well as degenerative changes are first only found in the region anterior to the equator, and are thus local phenomena. In the following weeks the number of accessory nuclei increases, and these nuclei are gradually found in most parts of the preparation, the largest number in the region anterior to the equator. 1 month after irradiation the first histolo-

gically identifiable lens fibre changes are seen. These occur in the equatorial region as swollen fibres and vacuolar formation. Some of the pathologic fibres posterior to the equator are nucleus containing (pseudo-epithelium). About 4 months after irradiation the cataract has become clinically diagnoseable and appears as numerous opacities peripherally in the posterior cortex. 14 months after irradiation considerable polymorphism of the lens epithelial nuclei with monstruosities are noticed. The pathologic epithelial changes have considerable distribution so that normal areas can scarcely be found at this time. Accessory nuclei are present during the whole of the observation period, their chromatin contents appear the same as for the main nucleus. Reparative processes after radiation insults are inconspicuous. Accessory nuclei and mitoses are only found in the ordinary lens epithelial cells. Formation of accessory nuclei has not been observed in starshaped cells, neither have mitoses been found in starshaped cells. Defects are to some extent compensated for by the swelling of neighbouring cells.

The formation of accessory nuclei is a conspicuous feature in the roentgen effect on the epithelium. The accessory nuclei may have been produced in two different ways: either through abnormal mitotic division or through direct amitotic division. POLITZER sums up the effect of roentgen irradiation on cellular division as follows: the number of mitoses diminishes immediately after irradiation (*primary effect*). Then follows an *interval without mitosis*, the duration of which depends on the size of the dose received. Finally reoccurrence of mitoses (*secondary effect*). The primary effect is characterised by pycnosis and pseudoamitosis, the secondary effect by rhexis, detachment of fragments of the chromosomes and formation of accessory nuclei. This applies to animal as to plant tissue, to pathologic and to normal tissue alike. POLITZER claims that accessory nuclei are formed through chromosome-rhexis, without subsequent moving towards the pole, and constrictive detachment of chromosome fragments. These chromosome fragments are, according to POLITZER, the origin of the accessory nuclei. In my material formation of accessory nuclei has been observed in the lens epithelium and in the epithelium of the conjunctiva and cornea. But accessory nuclei have not been observed post-irradiatively in connective tissue. In total lens epithelial preparations pathologic mitoses with detached chromosome fragments are observed after irradiation. These chromosome fragments may well, after their appearance, be interpreted as the origin of the accessory nuclei (Fig. 14). During the first 6 days after irradiation no mitoses at all are found in lens-epithelium. Later on an average 5—6 up to 10 mitoses may be found in every total lens epithelial preparation. Accessory nuclei are also present on the sixth day after irradiation, their number increases to such an extent that 2 weeks later hundreds are seen in total lens epithelial preparations.

The circumstance that accessory nuclei and mitoses appear almost simultaneously may indicate that formation of accessory nuclei is based on pathologic mitoses. Accessory nuclei are found in the ordinary lens epithelial cells only. Formation of accessory nuclei has not been observed in the starshaped cells, neither have mitoses been found in starshaped cells. This condition, the lack of mitoses and the lack of formation of accessory nuclei in the starshaped cells is interesting, and the interpretation may possibly be that the formation of accessory nuclei is based on detached chromosome fragments. In my preparations, on the other hand, the number of pathologic mitoses and number of accessory nuclei are decidedly disproportionate. This condition is fully in accordance with EFSKIND's findings in the peritoneal mesothelium of rabbits after roentgen irradiation. Also here disproportion between the number of mitoses in early stages and the number of finished products of pathologic division is significant. EFSKIND therefore considers formation of accessory nuclei through amitotic nuclear division most probable. A circumstance which may also support this hypothesis is the observed phenomenon in several of my preparations, that some accessory nuclei are connected with the main nucleus by a »stem» (Fig. 11), which gives the impression that the accessory nucleus is about to become detached. The possibility cannot be excluded however, that the interpretation of the stem is that the accessory and main nuclei are about to merge into one.

Accessory nuclei are comparatively equal in size. In the lens epithelium their average area is $3 \times 3\,\mu$, the average area of the corresponding main nuclei is $7.5 \times 8\,\mu$. In comparing the size of ordinary lens epithelial nuclei in uni-nuclear cells and the size of the main nucleus in cells containing accessory nuclei an interesting condition is observed. The main nucleus in poly-nuclear cells is invariably smaller than the nucleus in normal uni-nuclear lens epithelial cells. The area of the main nucleus in poly-nuclear cells measures, as mentioned, on an average $7.5 \times 8\,\mu$, whereas the nuclear area in normal uni-nuclear lens epithelial cells measures on an average $12 \times 12\,\mu$. In the formation of the small accessory nucleus the main nucleus of the cell thus becomes smaller than the average normal cellular nucleus.

The experimental series described shows that roentgen cataract in rabbits becomes clinically manifest only 4 months after irradiation, which also has been claimed by other authors (AULAMO, ROHRSCHNEIDER, PETER et al.). In histologic examination pathologic lens epithelial changes may be observed already in the first preparation examined, that is 24 hours after irradiation. Based on my experiments I believe it probable that roentgen cataract develops because of pathologic lens epithelial alterations. From the fibre-forming epithelium pathologic fibres grow in the equatorial region. The pathologic fibres gradually spread and disintegrate

in the subcapsular region of the cortex with formation of the clinical picture of the roentgen cataract. It is also probable that lens nutrition suffers because of pathologic changes in the remaining parts of the epithelium, which as is known, is important to nutrition. This development explains the long latent period between irradiation and clinical manifestation of the cataract.

SUMMARY

The microscopic structure of the rabbit lens under normal conditions and after roentgen irradiation is described, and the relation between structure and nutrition of the lens is discussed. The immediate and late effects on cellular division and cellular structure in different parts of the rabbit eye are described in detail and discussed. The observations seem to permit the conclusion that the roentgen cataract is produced by direct roentgen effect on the lens. No roentgen changes could be observed in the uvea, the retina and the optic nerve, except for slight hyperemia of the vessels.

ZUSAMMENFASSUNG

Es wird das mikroskopische Bild der Kaninchenlinse unter normalen Verhältnissen und nach Röntgenbestrahlung beschrieben, und die Beziehung zwischen Bau und Ernährung der Linse wird diskutiert. Die unmittelbaren und die Spätwirkungen auf Zellteilung und Zellbau in verschiedenen Teilen des Kaninchenauges werden eingehend beschrieben und diskutiert. Wie es scheint, erlauben die Beobachtungen den Schluss, dass der Röntgenstar durch direkte Röntgenwirkung auf die Linse erzeugt wird. An der Uvea, der Retina und dem Nervus opticus waren keine Röntgenveränderungen zu beobachten, mit Ausnahme einer leichten Hyperämie.

RÉSUMÉ

Description de la structure microscopique du cristallin du lapin dans des conditions normales et après irradiation aux Rayons Rœntgen, et discussion des relations entre la structure et la nutrition de l'organe. L'auteur décrit en détail les effets immédiats et tardifs sur la division et la structure cellulaires dans différentes parties de l'œil du lapin et en discute. Les observations semblent autoriser la conclusion que la cataracte des Rayons Rœntgen est causée par l'action directe des irradiations sur le cristallin. Aucune altération due aux Rayons Rœntgen ne put être observée, pas plus dans le tractus uréal que dans la rétine ou le nerf optique, à part une légère hyperémie vasculaire.

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AUS DER RÖNTGENABTEILUNG DES SERAPHIMER-KRANKENHAUSES, STOCKHOLM
(VORSTAND: DOZ. E. LYSHOLM)

ZUR RÖNTGENDIAGNOSE DES SUBDURAL-HÄMATOMS[1]

von

E. Lindgren

DYKE hat 1936 ein enzephalographisches Zeichen für Subduralhämatom beschrieben, das seiner Ansicht nach pathognomonisch ist. Er hat dieses Zeichen bei einem Fall beobachtet. Auf einer anterioposterioren Aufnahme war ein fingerförmes, diagonales Luftbündel vorhanden, das bei dem Sinus long. sup. begann und lateral-nach unten verlief. DYKE war der Ansicht, dass diese Luftmenge in einem subduralen Raum, zwischen der inneren Hämatommembran und der Arachnoidea enthalten ist. Das lateral und nach oben von dieser Luftmenge belegene dichte Gebiet stellt also das Hämatom dar, während das Gehirn medial von ihr liegt. DYKE hat in der Literatur ein ähnliches Bild gefunden, das von KOSCHEWNIKOFF und FRAENKEL beschrieben worden ist und als durch Atrophie verursacht gedeutet wurde; auf Grund der Ähnlichkeit mit seinem eigenen Fall hat DYKE dann (wahrscheinlich mit Recht) angenommen, dass das Bild durch ein subdurales Hämatom bedingt wurde. Falls dieses enzephalographische Bild in der Tat typisch für ein subdurales Hämatom wäre, so dürfte seine Bedeutung doch sehr klein sein. So weit es Verf. bekannt ist, wurde dieses Bild später nicht beobachtet. Bei dem grossen Material, das im Laufe der Jahre in der Röntgenabteilung des Seraphimer-Krankenhauses untersucht wurde und das aus der Nervenklinik (Vorstand: Prof. ANTONI) bzw. der Neurochirurgischen Abteilung (Vorstand Prof. OLIVECRONA) zur Untersuchung überwiesen wurde, kam somit dieses Bild niemals zur Beobachtung.

Allgemein wird angenommen, dass die enzephalographischen Veränderungen bei einem subduralen Hämatom derart beschaffen sind, dass sie von denen, die ein Tumor zu bedingen pflegt, nicht zu unterscheiden sind. BULL hat indessen bei dem Material des Seraphimer-Krankenhauses zeigen können, dass falls das Hämatom eine typische Lage hat, eine

[1] Bei der Red. am 13. IV. 1942 eingegangen.

zweckmässig durchgeführte Untersuchung mit grosser Sicherheit Aufklärung darüber ergibt, ob ein Hämatom vorliegt oder nicht. Kleine oder atypisch liegende Hämatome können hingegen atypische Veränderungen bedingen, die von denen, die bei Tumor vorkommen, nicht unterschieden werden können. Während der letzten Jahre kam die Röntgenuntersuchung des subduralen Raumes zu einer ausgedehnteren Anwendung, und zwar wie Verf. und andere Autoren bereits früher hervorgehoben haben, vor allem bei Verdacht auf Adhaerenzen zwischen Gehirn und Dura, aber auch bei subduralen Hämatomen. Früher wurde diese Untersuchung bei Fällen mit subduralem Hämatom nicht eigentlich in diagnostischer Absicht ausgeführt, sondern um die Grösse und Ausdehnung des nach Ablassung des Hämatomes entstandenen Hohlraumes zu ermitteln. Die Erweiterung der Erfahrungen hat indessen gezeigt, dass die röntgenologische Untersuchung des subduralen Raumes auch für die Stellung der Diagnose von grosser Bedeutung ist. Bei Enzephalographie kommt nicht selten, und zwar sowohl bei Lufteinblasung mittels Zysternen- als auch bei einer solchen mittels Lumbalpunktion, eine gewisse Luftmenge in den subduralen Raum. Nach Ablassen von Liquor mittels einer Zysternenpunktion bei Beckenhochlage des Patienten kann durch Lumbalpunktion in den subduralen Raum des Rückenmarks Luft eingeblasen werden, nach unseren Erfahrungen steigt doch die so eingeführte Luft nicht intrakranial auf. Bei gewissen Fällen ist es möglich zu erreichen, dass die Spitze der Punktionskanüle bei Zysternenpunktion zwischen Dura und Arachnoidea zu liegen kommt, und zwar dann wenn gleichzeitig lumbal Liquor abgelassen wird, in diesem Falle kann Luft in den Subduralraum des Schädels eingeblasen werden (ANTONI). Die so eingeführte Luftmenge ist freilich in der Regel nicht gross genug um eine zufriedenstellende Untersuchung evt. Adhärenzen zu ermöglichen. Damit die Adhärenzdiagnostik eine ausreichende Sicherheit erhält, ist nämlich eine grosse Luftmenge erforderlich, so dass das Gehirn deutlich von der Kalotte herabsinkt. Die Adhärenzen werden dabei gestreckt und sind dadurch leichter zu beobachten. Für die Diagnose eines Subduralhämatoms ist hingegen nur eine relativ geringe Luftmenge erforderlich. Die Diagnostik wird durch die einfache Tatsache ermöglicht, dass der Subduralraum normalerweise mit Ausnahme von denjenigen Stellen, wo er durch Gefässe und Pacchioni-Granulationen durchzogen wird, d. h. hauptsächlich in der Nähe des Sinus Long. sup., frei ist. Die subdural liegende Luft kann somit normalerweise frei verschoben werden. Ist hingegen an irgend einer Stelle ein Hämatom vorhanden, so kann die Luft dieses Gebiet nicht ausfüllen. Das Prinzip der Untersuchung wird, dass nachdem sich die subdurale Luft angesammelt hat, was am besten dadurch bewirkt wird, dass der Patient aufsitzt, die Luft an die Stellen verschoben wird, an denen das Hämatom, nach der Deformation des

Ventrikelsystems zu beurteilen, liegen kann. Es ist also erwünscht, dass Luft sowohl subarachnoidal als auch subdural eingeführt wird. Kommt die Luft nur subdural zu liegen, so wird die Untersuchung möglicherweise zeitraubender, da in diesem Fall vielleicht der ganze subdurale Raum untersucht werden muss. Nachdem die Hämatome in der Regel in der Gegend der Fissura Sylvii liegen, werden die wichtigsten Aufnahmen die sein, welche mit horizontaler Strahlenrichtung aufgenommen werden, wobei der Patient mit einer solchen Kopfhaltung liegt, dass die verdächtige Seite nach oben gedreht ist. Um die Anwendbarkeit der Methode zu beleuchten soll der folgende Fall angeführt werden:

D. E. ♂ geboren 1893. Patient ist im Februar 1941 in einem Stall ausgerutscht und hat dabei seinen Hinterkopf an einer Krippe angeschlagen. Er verlor das Bewusstsein nicht, war aber in den nächsten Stunden etwas schwindlig. Nach dem Trauma lag er einige Stunden im Bett, konnte aber dann seine Arbeit fortsetzen. In der nächstfolgenden Zeit hatte dann Patient Kopfschmerzen, erst ein bis zweimal in der Woche am Morgen, später mehr kontinuierlich. Von Anfang August an haben die Kopfschmerzen wieder nachgelassen. Während des Sommers hatte er auch Schwindelgefühl, das doch später nachgelassen hat. Während der zwei letzten Monate vor der Krankenhausaufnahme frei von Schwindel. In der Zeit, in welcher die Kopfschmerzen am schwersten waren, hat Patient auch erbrochen, seit August jedoch nicht mehr. Im Juni wurde Patient in ein anderes Krankenhaus aufgenommen, wo Papillenstase und eine Herabsetzung der groben Kraft des rechten Armes und Beines festgestellt wurde. Patient wurde der Neurochirurgischen Abteilung des Seraphimer-Krankenhauses überwiesen und im September 1941 daselbst aufgenommen. Aus dem Status: Keine Stauungspapillen. Im Augenhintergrund sieht man beiderseits temporal einige kleinere Blutungen, im übrigen aber keine objektiven Veränderungen. Eine sichere Herabsetzung der groben Kraft kann nicht mehr festgestelit werden. Röntgenuntersuchung des Schädels zeigte keine Fraktur auf. Enzephalographie am 4. 10. 1941: Das Ventrikelsystem ist um ungefähr 2 mm. nach rechts von der Mittellinie verschoben, weist aber keine lokale Deformierung auf. Das linke Temporalhorn ist nicht auffällig verschoben. Die subarachnoidal befindliche Luft liegt zum überwiegenden Teil über der rechten Hemisphäre. Rechts liegt eine ziemlich grosse subdurale Luftschicht vorhanden, auf der linken Seite eine kleinere. Auf der rechten Seite ist die Luft frei verschiebbar, auf der linken Seite kann sie frei über den oberen Teil der Konvexität verschoben werden, es ist jedoch nicht möglich die Luft zwischen die Kalotte und das Gehirn im Gebiete der Fissura Sylvii gelangen zu lassen. Die Untersuchung ergab also Zeichen für das Vorhandensein eines kleinen, linksseitigen subduralen Hämatoms. Operation am 11. 10. (Dr. WELANDER): Über den vorderen Teil der Fissura Sylvii auf der linken Seite wurde ein 2 kronenstückgrosser Defekt erzeugt. Die Dura erwies sich etwas dicker als normal. Sie wurde sternförmig eröffnet, wobei man ein typisches Hämatom gefunden hat. Die äussere Membran wurde eröffnet und es konnte eine kleinere Menge, z. T. koaguliertes Blut abgesaugt werden. Die innere Membran wurde teilweise entfernt. Der postoperative Verlauf war unkompliziert. Die Blutungen im Augenhintergrund haben sich bis zur Entlassung resorbiert.

Die Symptome bei diesem Fall sprachen für ein Subduralhämatom, das sich teilweise spontan resorbiert hatte. Das Aussehen des Ventrikelsystems gab keine deutliche Hinweise auf die Lokalisation des Hämatoms, die besonders geringe Dislokation, die doch vorhanden war, sprach dafür,

Abb, 1.

Abb. 2.

Abb. 3.

dass auf der linken Seite ein pathologischer Prozess vorliegen könnte. Eine unterschiedliche Verteilung der subarachnoidal belegenen Luft auf den Bildern muss immer mit grösster Vorsicht bewertet werden, da die Lage des Kopfes, nicht nur während der Lufteinblasung, sondern auch in der Zeit zwischen dieser und der Vornahme der Röntgenuntersuchung, für die Luftverteilung eine grosse Rolle spielen kann. Kommt indessen gleichzeitig mit einer mangelhaften Luftausfüllung der Furchen über einer der Konvexitäten auch eine Verschiebung des Ventrikelsystems nach der entgegengesetzten Seite vor, wie bei dem vorliegenden Fall, so kann der unterschiedlichen Luftverteilung eine grössere Bedeutung zugeschrieben werden als gewöhnlich. Den entscheidenden Beweis ergibt indessen das Verhalten der subduralen Luftmenge. Die in Abb. 1 wiedergegebene Aufnahme ist im Sitzen aufgenommen und zeigt, dass der obere Teil des Subduralraumes beiderseits frei ist. Abb. 2 ist mit horizontaler Strahlenrichtung aufgenommen. Die rechte Seite des Schädels liegt nach oben. Die Luft wird dabei, wie normalerweise, unter der Kalotte angesammelt. Abb. 3 ist in dereslben Weise aufgenommen, jedoch mit der linken Schädelseite nach oben. Innerhalb des lateralen Gebietes, das auf dem Bild von dem Strahlenbündel tangential getroffen wird, kann diesmal zwischen Gehirn und Kalotte keine Luft beobachtet werden. Bei einer geringen Veränderung der Lage des Kopfes kann indessen gezeigt werden, dass die Luft frontal und occipital zwischen Gehirn und Kalotte gelangen kann. Es muss also ein Prozess vor sich gehen, der die Luftausfüllung des Subduralraumes, ungefähr der Gegend der Fissura Sylvii und ihrer Umgebung entsprechend, verhindert. Hierbei handelt es sich um ein Subduralhämatom. Es scheint so, also ob das hier beschriebene röntgenologische Symptom wertvoller wäre als das von

DYKE, da es nach den bisher vorliegenden Erfahrungen beurteilt nur sehr selten eintrifft, dass zwischen das Hämatom und das Gehirn Luft eindringt. Die Methode dürfte bei kleinen Hämatomen am wertvollsten sein. Da indessen die Deformierung des Ventrikelsystems gerade bei diesen Hämatomen gering und uncharakteristisch sein kann, bedeutet die Untersuchung des Subduralraumes bei der Diagnosestellung in diesen eine wertwolle Ergänzung.

ZUSAMMENFASSUNG

Ein neues röntgenologisches Zeichen für Subduralhämatom wird beschrieben. Die Luft im Subduralraum füllt die Gegend, in der das Hämatom liegt, nicht aus.

SUMMARY

Description of a new roentgenological sign of subdural haematoma. The air in the subdural chamber does not fill up the space in which the haematoma has its seat.

RÉSUMÉ

Description d'un nouveau signe radiologique de l'hématome sous-dural. L'air, dans l'espace sous-dural, ne remplit pas la région où se trouve l'hématome.

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FROM THE ROENTGEN CLINIC OF THE NØRRE HOSPITAL, COPENHAGEN
(CHIEF: EM. SAMUELSEN, M. D)

TUBEROUS SCLEROSIS WITH CHANGES IN LUNG AND BONES[1]

by

Em. Samuelsen

In medicine we find at the different times fairly definite systems of more or less well defined diseases and symptom complexes. They are constructed on the basis of observations and speculations, and are always inexact and insufficient. In practical life the cases must have a diagnosis; this applies first and foremost to the practicing physician, but also very much to the hospitals. We are therefore all now and then faced with having to place pathologic pictures in more or less wrong rubrics. This may be because the symptoms are vague, our knowledge and examination insufficient or our interpretation wrong, but also because the system at the given time simply lacks the rubric in which the disease in question rightly should belong. I wish to report here a case of this kind, because SCHINZ, in his large (2,000 pages) textbook of roentgen diagnosis,[2] so far as I have been able to see does not mention this disease at all.

The patient was a woman, aged 49, whose lung picture several radiologists in the course of time have had occasion to study, because she in the later period of her life became an inmate of not a few hospitals, one after another. As a child, she is stated to have had the usual children's diseases, and while she was growing up to have suffered from anemia and scrofula. In 1928, when she was thirty-six, she was hospitalised for hemoptysis. The diagnosis of the service to which she was admitted was mitral heart disease (stenosis). In 1932, she was admitted to another hospital, suffering from fatigue, dyspnea, cough and expectoration. The diagnosis there was chronic heart disease with lung stasis, hemoptysis (? pulmonary tuberculosis). In 1933, she was in a third hospital, for examination with a view to an invalidity pension. The diagnosis now was chronic miliary tuberculosis, and she was granted such a pension from June 1933. As she was losing weight steadily and on account of increased blood sedimentation reaction, she was shortly afterwards through the agency of a tuberculosis station sent to a tuberculosis hospital, where she stayed from July to December, 1933. A roentgenograph of her thorax

[1] Read at the meeting of the Danish Radiological Society 25th Oct., 1941; submitted for publication Febr. 18, 1942.

[2] SCHINZ, BAENSCH and FRIEDL: Lehrbuch der Roentgendiagnostik; 1939.

showed both pulmonary fields in their entire extent covered with numerous close-set, in some places confluent, uniform, milium-sized foci, characteristic for miliary tuberculosis. About the heart shadow there was nothing pathologic. But Pirquet and Mantoux tests were negative, and no tubercle bacilli could be demonstrated either in the sputum, in the water from stomach-sluicing or in catheter urine. The hospital's diagnosis was therefore chronic miliary tuberculosis and chronic heart disease, both with a question mark. Her next four-five years were spent in a home for the care of tuberculous women, from which she again, in 1938, was admitted to the tuberculosis hospital. At the roentgen examination there, her lungs were found to present exactly the same picture as five years before. In view of the anamnesis it was now thought that the diagnosis of miliary tuberculosis could no longer be upheld, and Boeck's sarcoid was suggested. though with the addition that the absence of any enlargement of the hilus, and the circumstance that the spots had no relation to the bronchial and vascular design, would seem to speak against that disease. Roentgenographs of the hands showed in the fingers both some opacities and some round and oval rarefactions, which seemed to further support the diagnosis of Boeck's sarcoid. Roentgen examination of the feet showed nothing with certainty abnormal, and roentgen examination of the cranium (the cella turcica) normal conditions. Other investigations, such as biopsy from the tonsils and examination of the eyes, were negative both as regards tuberculosis and as regards Boeck's sarcoid. The vital capacity of the lungs was reduced from 3 liters to 1.5 liter.

In August, 1938, the patient was transferred to the Copenhagen General Hospital under the diagnosis of Boeck's sarcoid and imbecility, and remained there until her death, part of the time in sick ward, part of the time in the nursing home. Examination showed about the same condition as before. Thus, there was in the lung picture seen a disseminated, miliary infiltration, symmetrically distributed in both pulmonary fields (Fig. 1). This picture remained unchanged; only in the very last roentgenograph, from December, 1940, six months before the patient's death, was there, besides, a veiling of the left basal field, corresponding to a pleural affection. The roentgenographs of the hands (Fig. 2) showed periosteal thickenings on the metacarpal bones, and in the fingers both some opacities and some osteoporosis with cyst-like rarefactions. In several places the cortex was irregularly arroded. The patient died in June, 1941, under symptoms of cerebral hemorrhage.

Necropsy Findings

Lungs. — The right lung is of medium size, the left moderately diminished. The left pleura is in its lower part fibrously thickened, and the left pleural cavity contains 250 ccm. of thin, yellowish fluid. The shape is natural; the color dark brown, uniform, speckled with black. The consistence is increased, homogeneous, firmly elastic, air-containing throughout. On the surface of the lungs (Fig. 3) are seen numerous greyish elevations, from millet-seed to pea-sized, representing small smooth-walled, air-filled round cavities. On the section surface, the tissue is dark brown, finely dotted, marbled, spongy, with reticulated, firmly elastic streaks and numerous small, round, air-filled cavities. No tubular areas simulating bronchiectasis. No large, solitary cysts. No acutely pneumonic areas. No signs of tuberculosis, Boeck's sarcoid or tumor formation. Trachea and bronchi natural. The hilus glands small, anthracotic, without calcium contents. *Macroscopic necropsy diagnosis:* Diffuse, small-cystic transformation of brown, pigmented, sclerotic lung tissue. *Microscopy:* In the lungs are seen many round, smooth-walled cavities, from the size of a millet- or hemp-seed to twice the size of a pea; fairly uniformly distributed through the tissue, though in some places slightly grouped. Those nearest the surface project hemispherically on the pleura. The cavities have in places a thin lining of cells,

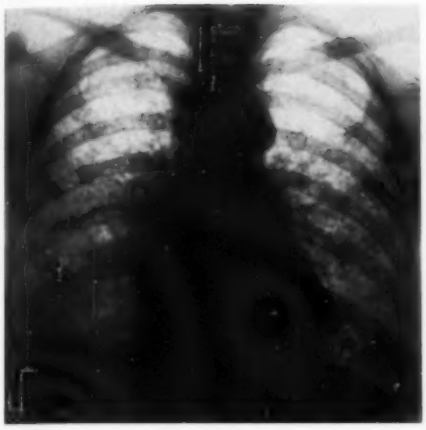

Fig. 1.

Fig. 2.

Fig. 1. Disseminated miliary infiltration, symmetrically distributed over both pulmonary fields (see Fig. 6 c).

Fig. 2. In the metatarsal bones some periosteal thickenings. In the fingers some opacities and some osteoporosis with cyst-like rarefactions. The cortex in several places arroded.

resembling an endothelium, but are otherwise empty. It seems that they must be considered as distended alveoles, possibly in connexion with distension of the nearest adjacent, finest bronchial ramifications. The pulmonary tissue between them is partly normal, partly atelectatic, and partly — and especially — the seat of a slightly greater thickening of alveolar septa (Fig. 4). This thickening is due to increase in the quantity of connective tissue and the presence of a moderate number of muscle cells. The connective tissue is poorly furnished with cells; the muscle cells either lie isolated or form small streaks and bundles. The cells in both types of tissue are normal. The vascularity of the alveolar septa seems on the whole to be less than normally. In the pulmonary tissue there is neither edema, fresh hemorrhages, acute pneumonic changes, carnification nor any structures characteristic for tuberculosis of Boeck's sarcoid. On the other hand, there is a very considerable accumulation of blood pigment. This lies inside the alveoles and, to a lesser extent, in the septa, forming large or smaller granular masses and for a considerable part ingested by phagocytising cells (heart-disease cells). The distribution of the blood pigment in the lung tissue is noticeably irregular, the accumulation being mostly greatest within groups of alveoles whose walls are thickened. This irregular occurrence of areas with thickened alveolar septa and accumulation of blood pigment not infrequently gives the lung tissue a certain speckled or slightly knobby appearance. There are no circumscribed nodular formations. — *Microscopic necropsy diagnosis:* Diffuse myofibrosis of the lungs with medium to high grade cystic degeneration. High grade hemoglobinic pigmentation of the lungs.

Fig. 3. Fixated preparation of the lung. Numerous small cysts, representing distended pulmonary alveoles, are seen, partly as projecting bullæ on the pleura, partly as small, air-containing cavities in the section surface of the lung.

Heart. — The heart is slightly enlarged. The mitral and aortic valves show sequelæ of a healed endocarditis in the form of thickenings and adhesions of the valves and shrunk and thickened tendinous cords. In the left atrium there is a brown, rather loosely fixed parietal thrombus, which projects from the auricle.

Brain. — The brain is fully medium-sized. The membranes natural. No malformations or contractions. In the right hemisphere there are, both anteriorly and medially, as well as laterally, specially in the right occipital lobe, several not sharply circumscribed, hyperemic areas, under which the tissue is soft, degenerating, granular and reddishly speckled. There are no demonstrable thrombi in the larger vascular branches. No cysts. No hemorrhage in the region of the basal ganglion. Over greater or lesser, irregularly distributed areas of the brain surface, the gyri are enlarged, broader and flatter than normally; and in some places there are vaguely delimited circular formations with a small cleft or umbo in the middle. The consistence of the enlarged gyri is not visibly changed, but in most places the cortical design is lacking; the white substance for a distance of a couple of centimeters extending all the way out to the cerebral membranes (Fig. 5). Microscopy shows gliosis. In the chorioid plexus on the right side there is a soft, elastic, rough-surfaced tumor-like formation, barely as large as a hazelnut, projecting into the lateral ventricle. In another part of the chorioid plexus there is a round, fibrous node, the size of a pea, which contains calcareous concrements. — *Necropsy diagnosis:* (1) Multiple large and small brain infarcts, with hemorrhage and emollition; (2) in various places moderate changes of the gyri, resembling tuberous sclerosis; (3) tumors in the chorioid plexus.

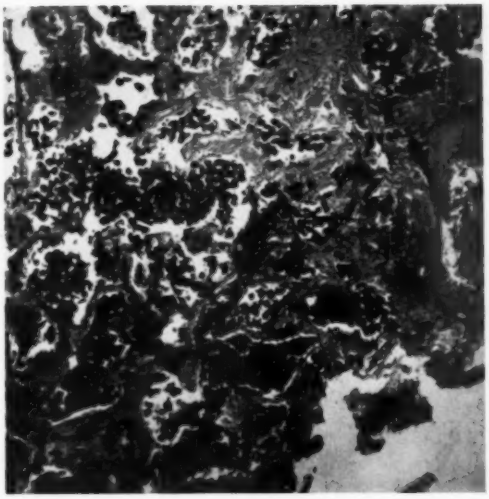

Fig. 4.

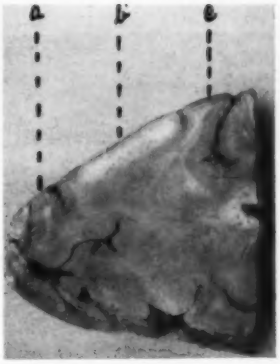

Fig. 5.

Fig. 4. Photomicrograph of sclerotic lung tissue (× 75). The alveoles are reduced in number and contain large quantities of blood pigment. The alveolar septa are very much thickened, which is chiefly due to increase of the connective tissue, and in a minor degree to the occurrence of muscle cells.

Fig. 5. Fixated preparation of portion of the brain. Tuberous sclerosis of the brain. At *a* and *c* are seen normal gyri with clearly delimited cortical- and marrow substances. At *b* a broadened gyrus with tuberous sclerosis; the cortical substance has disappeared and has become replaced by glia tissue, which extends all the way out to the cerebral membranes.

Kidneys. — The surface of the kidneys is in parts finely, in other parts coarsely granulated, bosselated, chiefly owing to the projection of large and small, pale, firmly elastic nodes. Otherwise the renal tissue is of normal appearance, rather dark and reddish. On section surfaces are seen numerous roundish, pale, solid, sometimes slightly marbled, firm, from millet-seed to olive-sized nodules, apparently developed in the cortex. The pelves and vessels are natural. *Microscopy* of the nodules shows a uniformly dense structure of the tissue, rather rich in cells. The cells are medium-sized spindle-shaped, stain brown when treated by v. Gieson's method and resemble muscle cells. They lie in bundles and in streaks of varying thickness and running in different directions. Through the tumor tissue there extends a finely meshed stroma of connective tissue, which is poor in cells, hyalinised, and in several places gathered into finely meshed, a little more solid nets. Irregularly distributed in the tumor tissue are seen medium-sized vessels, lying close to each other, which give the tissue a hemangiomatous appearance. The vessel walls are thickened, hyalinised, and the lumina partly narrowed. There is no calcification or thrombus formation. In some places there are somewhat larger vascular branches, presumably of the arterial type, the media of which continue directly over into the tumour masses. No necroses or hemorrhages. In a few places outside the area of the nodules there seems to be small streaks of connective tissue interspersed with muscle cells, some-

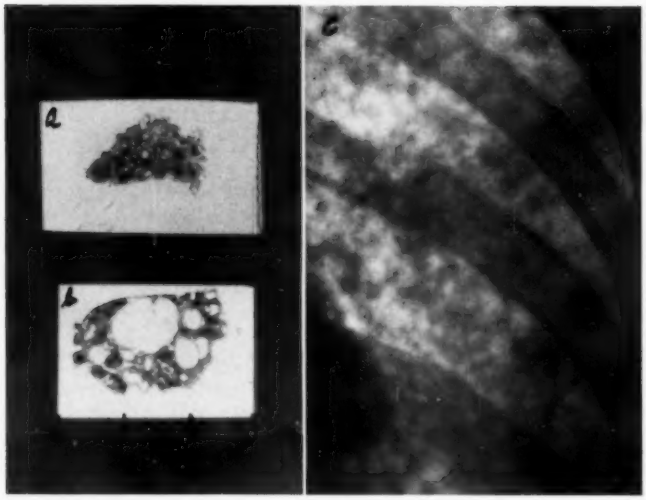

Fig. 6. Section preparations (not photomicrographs) in natural size. In *a* are seen several densified, dark areas, 1 to 2 millimeters large, in comparatively normal lung tissue. *b* shows similar small patches in highly cystically transformed lung tissue. The largest cyst measures 1 cm. in its broadest diameter. At roentgenologic examination, the small patches produce a miliary roentgen picture, as seen in *c*, where a detail of the roentgenograph in natural size shows numerous small shadows of corresponding proportions.

what resembling the septal changes in the lung. *Macroscopic necropsy diagnosis:* Multiple large and small tumors in the kidneys. *Microscopic necropsy diagnosis:* myomas (and myomatosis) of the kidneys, with hemangiomatous, partly hyalinised portions. (Prosector SVEND PETRI).

The case is thus one of a middle-aged woman with a chronic pulmonary disease which on roentgen examination gave a finely spotted, miliary lung picture. This was at first interpreted as miliary tuberculosis, but no tubercle bacilli could be demonstrated either in the sputum, in the water from stomach-sluicing or in catheter urine, and also the tuberculin tests were negative. As the lung picture remained unchanged for years, the diagnosis of miliary tuberculosis was abandoned, and it was supposed that the case was one of Boeck's sarcoid; an opinion which seemed to be supported by roentgenologically demonstrable changes in both her hands. But further investigations with a view to that diagnosis, too, were negative. The necropsy showed no signs of tuberculosis or of Boeck's sarcoid, but revealed a cystic lung with numerous small cysts and increased interstitial stroma built up of connective tissue and smooth muscle tissue.

Fig. 6 shows the conditions that resulted in the miliary lung picture. It is photographs — not photomicrographs — of section preparations, and the elements are shown in their natural size. In the upper picture (a) we see some roundish and angular areas, denser and darker than their surroundings and 1—2 millimeters large, which lie scattered in between comparatively normal lung tissue. In the lower picture (b) there are similar small patches, embedded in highly cystically transformed tissue. The cysts are in different sizes, from quite diminutive to several millimeters large, and the largest in the preparation measures 1 centimeter in diameter. As regards the small patches, which, as we have said, are from 1 to 2 millimeters large, their size is such that they can just barely be seen in sharply traced lung pictures, and corresponds to that of small miliary granules. We have here a demonstration, and a natural explanation, of how we got a miliary lung picture. But the small nodular formations are not due to tuberculosis or to Boeck's sarcoid; they are due to the fact that the content of air in portions of the lung is greatly diminished, and the stroma, which is built up of smooth muscle tissue and especially of connective tissue, increased; and in these portions there is moreover a considerable accumulation of pigment.

To resume, we have the following pathologic findings in the case:

1) Irregular, nodular or tuberous, sclerosis in the lungs, with small-cystic pulmonary degeneration.

2) Sequelæ after an old endocarditis, and a parietal thrombus in the heart.

3) Multiple, benign tumours in both kidneys.

4) Tuberous sclerosis of the brain; two small tumors in the chorioid plexus, and multiple brain infarcts with hemorrhage and emollition.

5) Roentgenologically demonstrable changes in both hands.

We are now confronted with the question of the combination of these pathologic conditions, and whether it is possible to make them fit naturally into a single, more or less known pathologic picture.

A similar case has recently been reported from Sweden.[1] In a woman, aged 32, who had two years previously been admitted to a hospital on account of spontaneous pneumothorax, there was demonstrated a bilateral, chronic affection of the lungs, the only clinical symptom of which, besides the spontaneous pneumothorax, was increasing dyspnea. On

[1] Berg and Vejlens: Maladie kystique du poumon et sclérose tubéreuse du cerveau. Acta Paediatrica, *26*, 16, 1939.

Berg and Zachrisson: Cystic Lungs of rare Origin. Tuberous Sclerosis. Acta Radiologica, *22*, 425, 1941.

Vejlens: Specific pulmonary Alterations in tuberous Sclerosis. Acta Pathologica, *18*, 317, 1941.

necropsy, both lungs were found large and voluminous, and the pleuræ dotted with pea- to hazelnut-sized bullæ. On the section surfaces, the lung resembled a sponge, the lung tissue being interspersed with numerous small cavities embedded in a thick, firm tissue of greyish-brown color, somewhat reminiscent of lung-stasis tissue. The cysts had no apparent relation to the bronchial or vascular ramifications. Microscopy showed that only small remnants of the normal parenchyma of the lung remained. For the rest, the lungs consisted of cyst-like cavities of every conceivable size and shape, and between these of an interstitial tissue, which was greatly increased and made up of connective, vascular and smooth muscle tissue. The most prominent element was the muscle tissue, which had the character of myomatous tumor tissue. Some of the cysts were covered with epithelium, but most of them had no such covering. The brain was the seat of tuberous sclerosis. On the surface there were no visible changes, but the frontal lobes and adjacent portions of the parietal and temporal lobes contained numerous palpable, resistant areas, from pea- to hazelnut-sized, which were due to proliferation of neuroglia. Besides, the patient had PRINGLE's nævi of the face and unguinal fibroma of some of the fingers and toes. In the kidneys were found numerous lesser tumors. The reporting authors speak of the lung affection as exceptionally uncommon. Whether this is the case is perhaps to be doubted; it has before been seen that when a hitherto unknown disease had once caught the attention, it was found to occur more often than at first supposed.

For the present it is debatable what name should rightly be given to this pulmonary affection, which is characterised by general, small-cystic degeneration of the lung and proliferation of connective tissue, smooth muscle tissue and, perhaps, vascular tissue, in the septa between the cysts and the alveoles. BERG and VEJLENS call it cystic lung disease, BERG and ZACHRISSON cystic lung of rare origin, while VEJLENS designates it as specific pulmonary alterations in tuberous sclerosis or, simply, as tuberous sclerosis of the lung.

Tuberous sclerosis was formerly considered to denote specifically tuberous sclerosis of the brain, — the nodular hardening of that organ. The originator of the name was BOURNEVILLE, who, since 1881, reported a number of cases. As the result of studies by PRINGLE, PONTICK and VOGT it came to be recognised that in tuberous sclerosis there is a definite connexion between the changes in the brain and certain characteristic skin diseases and tumours in internal organs. According to JACOBY's treatise in the »Handbuch der Neurologie» (1936), tuberous sclerosis is characterised by the existence in various organs, such as the brain, the retina, the skin, the heart, the kidneys and on the mucosæ, of tumor-like malformations, usually occurring in considerable numbers and in all sorts of combinations.

When we examine the state of the various organs in cases of tuberous sclerosis, the macroscopic appearance of the brain alone will usually suffice to make the diagnosis sure. We find in the cerebral cortex two kinds of changes; in the first place a more or less diffuse involvement of one or several gyri, which in places appear broadened, plump and sclerotic, but without any interruption of the course of the convolutions in question; in the second place more circumscribed, nodular formations, marked off from the surrounding relief of the convolutions by a circular furrow and often with an umbo-formation on the surface. In most cases, these changes, the former as well as the latter, will be fairly visible on the fresh brain owing to their whitish or whitish-grey color; and more clearly, still, will they become revealed by palpation, owing to their firm consistence, which may amount to cartilaginous hardness. Also the ventricles of the brain may contain tumor-like formations, — nodules of varying size, which as a rule project into the cerebral cavities and sometimes calcify. Nodules may occur, moreover, in the medullary substance, in the large central ganglia and — though very rarely — in the cerebellum and in the spinal marrow. The microscopic picture of the changes in the brain are said to be very characteristic. The limits of the cortex towards the marrow are ill-defined, staining of the glia shows strong hyperplasia, and there are large atypical cells, partly glia cells, partly ganglion cells.

In the classical cases, the disease expresses itself in psychic symptoms in the form of epilepsy and mental deficiency. The convulsions may occur as typical epileptic attacks, Jackson's epilepsy or in other forms; the mental impairment may range from debility through imbecility to complete idiocy. But most epileptic and mentally deficient subjects do not have tuberous sclerosis, and on the other hand that disease may be present without giving psychic symptoms. The diagnosis of it can therefore be very difficult, and can as a rule *in vivo* be established only by the aid of the characteristic skin diseases and the retinal changes revealed by ophthalmoscopy.

The most oustanding cutaneous symptom is Pringle's nævi, also called sebaceous adenomas, which shows itself in numerous, about pinhead-sized nodules in the face, symmetrically distributed over the nose and the adjacent portions of the cheeks, and often specially pronounced in the nasolabial furrows. Their appearance and color may become changed somewhat by the occurrence of small telangiectasies on the top of the nodules. Small nodules may occur also on other parts of the body, for instance as a hyperkeratotic nævus on the back. Very characteristic, too, is the subungual fibromatosis with small fibromas along the margins of the nails. They compromise the growth of the latter and grow out again if removed. The retinal symptoms consist in small, white

spots or distinct papillomas, mostly situated in the neighborhood of the papilla of the optic nerve. They are glia formations issuing from the retina.

Besides these cerebral, cutaneous and retinal changes there are in tuberous sclerosis also characteristic tumors in the internal organs. Thus, renal tumors are very frequent; they are present in up to 80 per cent of cases. They are usually multiple, very often bilateral, oftenest from the size of a pinhead to that of a hazelnut, but sometimes much larger. They are mixed tumors, composed of adipose connective and smooth muscle tissue. They can appear under different names according to the quantities and proportions in which the different components occur. They are situated either intrarenally or perirenally, and are nearly always benign and give no clinical symptoms. Far more infrequent is the occurrence of cardiac tumors. These are rhabdomyomas composed of immature muscle cells, and occur as small nodular formations in various parts of the heart, specially on the septum, in the anterior wall, on trabeculæ and papillary muscles, oftenest just underneath the endocardium. Exceptionally, also other internal organs may be the seat of pathologic changes.

After thus having reviewed the anatomical manifestations of tuberous sclerosis, we come to the question of the nature of these changes: whether they are malformations in the structure of the tissues and organs or true tumors. Some authors put emphasis on what points to malformation, others on the tumorous character of the alterations. Usually, the disease is characterised as something between a malformation and a neoplasm; the tuberous foci having a nodular, tumor-like appearance, but not the tendency to growth shown by true tumors. It is stated to be a congenital disturbance of development, but the genesis is not clear. As the endocrine organs sometimes have shown certain changes, the possibility of some disturbance of the equilibrium of the endocrinous system has been suggested, but nothing positive is known.

As regards the pulmonary affection especially, it is, as already mentioned, by VEJLENS (in Acta Pathologica, 1941) considered as one of the forms in which the tuberous sclerosis manifests itself. His patient had since childhood had characteristic skin diseases in the form of Pringle's nævi and subungual fibromas of some fingers and toes. The necropsy revealed tuberosclerotic changes in the brain and multiple benign mixed tumors in the kidneys, besides a splenoma in the spleen. As regards the affection of the lung, he considered the smooth muscle tissue as the principal element and maintained that it had the unmistakable character of tumor tissue and a structure similar to that in true myomas. He concluded from this that it also in the lung affection was a case of specific changes in the tuberous sclerosis.

In our case, the patient also had marked tuberous sclerosis of the brain, and in both kidneys multiple, benign mixed tumors, which gave no clinical symptoms. At the necropsy the pulmonary finding was exactly the same as in the Swedish case. There were numerous air-containing bullæ on the surface, and in the parenchyma many small cysts with increased, spongy consistence of the pulmonary tissue. In both cases, the microscopy showed numerous small cavities, most of them without epithelial lining, and greatly increased stroma. In our case, the strengthened, sclerotic stroma was due especially to a great increase of connective tissue, but in between the latter there were also distinct leiomyotic elements, partly as single cells, partly in small bundles and streaks. The cells in both types of tissue were here normal, though, and the smooth musculature did not look myomatous. In the kidneys, on the other hand, we found numerous myomas and also, outside the area of the nodules, small streaks of connective tissue interspersed with muscle cells, which reminded of the changes in the septa of the lungs. The muscles are, of course, a characteristic element of the tissue, but it is perhaps somewhat uncertain how much importance should be attached to the myomatous structure. It may perhaps even be possible to find tuberous sclerosis of the lungs without any occurrence of muscle cells. If we look at the kidneys, as regards which the conditions are best known, we find there the benign mixed tumors, which may contain adipose tissue, connective tissue, muscle tissue and vascular tissue in greatly varying proportions, and which therefore appear under many different names, — lipomas, angiolipomas, fibrolipomyomas, angiolipomyomas (cf. KAUFMANN: Lehrbuch d. speziellen pathologischen Anatomie; last edition, 1941, p. 1843). It lies near to think that the condition in the lungs, in cases of tuberous sclerosis, as regards the tissue elements is somewhat similar to that in the kidneys; and the possibility of finding a tuberous sclerosis without muscle cells undoubtedly exists. As regards the question of the origin of the musculature, it seems that microscopy of the kidneys might give information, because we in the microscopic preparations sometimes found slightly larger vascular branches, presumably of the arterial type, whose media continued directly over into the tumor masses.

On the basis of our own case, there is a feature which I particularly wish to emphasise; namely, the nodular form in which the disease manifested itself in the lung. As the section preparations show (Fig. 6), the pathologic, sclerotic tissue occurred for a very great part in small portions measuring from 1 to 2 millimeters, which is precisely what gives the roentgenologic lung picture the finely spotted, miliary appearance. The affection in the lung in this patient thus shows a marked tendency to develop in a nodular form; and this corresponds exactly with the occurrence of the tuberous sclerosis in other organs, specially in the

brain, from the nodular sclerosis of which the disease has got its name. The characteristic cutaneous affections and the changes in the retina present themselves in a corresponding manner; thus, Pringle's nævi with numerous small nodules in the face, the subungual fibromatosis with small fibromas along the margins of the nails, and also the papillomas on the gums and the small spots and papillomatous formations in the retina. In the internal organs, we find in the heart small, roundish rhabdomyomas, and in the kidneys tumors of various sizes. As we see, the nodular form is predominant everywhere.

As the affection of the lung thus, both as regards the elementary components of the tissue (connective tissue and smooth muscle tissue) and in its nodular occurrence, shows the same character as tuberous sclerosis in other internal organs, specially in the kidneys, it is on all accounts justified to conclude that these pulmonary changes are specific and are one of the manifestations of the tuberous sclerosis.

The accumulation of pigment, which presumably is something special in our case, is no doubt due to the patient's heart disease with its numerous hemorrhages. It is namely so that by hemoptysis only the bronchi become emptied of blood, while the alveolar filling must be eliminated by phagocytosis. This process can apparently take place to a sufficient extent only in normal lung tissue, whereas the sclerotic portions, with the thick, rigid, alveole walls, owing to poor circulation of the blood become the seat of accumulations of blood pigment. As we have seen, the pigment lay chiefly inside the alveoles and was for a rather considerable part ingested by phagocytes (heart-disease cells). Also the explanation of another necropsy finding must be looked for in the heart; the multiple brain infarcts with bleeding and emollition being probably due to small, detached portions of the parietal thrombus in the left atrium.

Finally, it must be mentioned that if it should be preferred to call the pulmonary affection cystic lung rather than tuberous sclerosis it must at any rate be with the understanding that it is of a character entirely different from the usual congenital cystic lungs with the quite thin, delicate walls. It is true that also in the latter the walls may sometimes become broad and thick, but this occurs as the result of infection and inflammatory infiltrations in the surrounding tissues; whereas it in tuberous sclerosis is a matter of interstitial leiomyomatosis and fibromatosis with secondary small-cystic changes in the lung.

A last thing to be spoken about is the roentgenologically demonstrated changes in the hands. Besides the tuberosclerotic changes in the brain, the characteristic skin affections and the typical tumors in internal organs, the literature also in a few instances mentions changes in bones. These have been observed partly in the cranium, partly in the hands

and feet. Thus, in 1935, DALSGAARD-NIELSEN[1] reported a case of tuberous sclerosis, in which the roentgenographs not only showed calcifications in the cerebrum, but also hyperosteotic areas in the cranial wall. Also GOTTLIEB and LAVINE[2] found opacities and rarefactions in various parts of the cranium of a patient with tuberous sclerosis, and, moreover, scattered periosteal thickenings and small cyst-like rarefactions in the bones of the hands and feet of the same patient. So far as I have been able to judge from the reproduced roentgenograph of one of the hands, it had exactly the same appearance as in our patient. It must therefore be supposed to be a roentgenologic picture of specific osseous changes typical for tuberous sclerosis. Whether these changes are possibly due to small fibromas or similar small, benign tumors in the periosteum and bone marrow is probably not known, inasmuch as it does not seem that any pathoanatomic examination had been made of the hands.

My object with this paper has been (1) to present the actual facts concerning a seldom occurring pathologic picture of long duration, considered from a postmortal view; (2) to account for the anatomical basis of a miliary lung picture which was neither miliary tuberculosis nor Boeck's disease, as supposed while the patient was alive; (3) to give an orientation in regard to the forms in which tuberous sclerosis manifests itself; and (4) to show that both the pulmonary and the osseous changes observed in the patient must probably be considered as elements of the heterogeneous, protean pathologic picture of tuberous sclerosis.

SUMMARY

The author reports the case of a woman, aged 49, with a chronic affection of the lung, which on roentgen examination gave a finely spotted, miliary lung picture that in the beginning was considered as characteristic for miliary tuberculosis; but the tuberculin tests as well as the examinations for tubercle bacilli were all negative. As the roentgenologic picture remained unchanged for years, the diagnosis of miliary tuberculosis was abandoned and the case judged to be one of Boeck's sarcoid; which was apparently supported by the presence of small, cyst-like rarefactions in the bones of the fingers.

The necropsy showed a »cystic lung» with numerous small, air-containing cavities (distended alveoles) and sclerosis of the lung chiefly due to increase of the connective tissue and, in a minor degree, to the occurrence of smooth muscle. Besides, the patient had tuberous sclerosis of the brain and multiple, benign tumors of both kidneys.

By means of section preparations it was demonstrated that the sclerosis of the lung had a marked tendency to nodular occurrence corresponding with the manifestations of the tuberous sclerosis in other organs, and that small patches, from 1 to 2 millimeters large, with thickened alveole septa and accumulations of pigment, were the anatomical basis for the occurrence of the miliary roentgenologic picture.

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[1] DALSGAARD-NIELSEN: Nordisk medicinsk Tidskrift; *10*, 1541, 1935.

[2] GOTTLIEB and LAVINE: Archives of Neurology and Psychiatry; *33*, 379, 1935.

The author shows that the lung affection (tuberous sclerosis of the lung) and the changes in the bones of the fingers, as well as the tumors of the kidneys and the tuberous sclerosis of the brain, all belong to the heterogeneous pathologic picture of tuberous sclerosis.

ZUSAMMENFASSUNG

Verf. berichtet über den Fall einer 49-jährigen Frau mit einer chronischen Lungenerkrankung. Die Röntgenuntersuchung ergab ein miliarfeinfleckiges Lungenbild; dieses wurde anfangs als für Miliartuberkulose charakteristisch angesehen; aber sowohl die Tuberkulinproben wie die Untersuchungen auf Tuberkelbazillen fielen alle negativ aus. Da das Röntgenbild Jahre hindurch unverändert blieb, verliess man die Diagnose »Miliartuberkulose» und meinte nun, einen Fall von Boeckschem Sarkoid vor sich zu haben; diese Auffassung wurde scheinbar gestützt durch das Vorliegen kleiner, zystenähnlicher Aufhellungen in den Knochen der Finger.

Die Obduktion zeigte eine »Zystenlunge» mit zahlreichen kleinen, lufthaltigen Hohlräumen (erweiterten Alveolen) und Sklerose der Lungen, hauptsächlich infolge einer Vermehrung des Bindegewebes und — in geringerem Masse — infolge des Vorkommens. glatter Muskulatur. Ausserdem hatte Pat. eine tuberöse Sklerose des Gehirns und multiple benigne Tumoren beider Nieren.

An Hand von Sektionspräparaten erwies sich: Die Sklerose der Lungen zeigte eine ausgesprochene Neigung zu Knötchenbildung entsprechend den Erscheinungen der tuberösen Sklerose in anderen Organen, und kleine, 1 bis 2 mm messende Stellen mit verdickten Alveolensepten und Pigmentanhäufungen bildeten die anatomische Grundlage für das Auftreten der miliaren Fleckung im Röntgenbild.

Verf. zeigt, dass sowohl die Lungenerkrankung (tuberöse Sklerose der Lungen) und die Veränderungen in den Knochen der Finger wie auch die Tumoren der Nieren und die tuberöse Sklerose des Gehirns, alle zu dem heterogenen pathologischen Bilde der tuberösen Sklerose gehören.

RÉSUMÉ

L'auteur relate le cas d'une femme de 49 ans, atteinte d'une affection pulmonaire chronique qui à l'examen radiologique donnait l'image finement tachetée d'un poumon granuligne, ce qu'au début on considéra comme caractéristique d'une tuberculose miliaire; mais les tests à la tuberculine et la recherche des bacilles de Koch étaient tous négatifs. L'image radiologique restant sans changement pendant des années on abandonna le diagnostic de granulie et on considéra qu'il s'agissait d'un cas de sarcoïde de Boeck; cette hypothèse semblait appuyée par la présence de petites raréfactions, d'aspect kystique, dans les os des doigts.

L'autopsie fit découvrir un »poumon kystique», avec nombre de petites cavités plaines d'air (alvéoles distendus), et une sclérose pulmonaire due surtout à une augmentation du tissu conjonctif, mais attribuable aussi, à un moindre degré, à la présence de tissu musculaire lisse. En outre le sujet présentait de la sclérose tubéreuse du cerveau et des tumeurs bénignes multiples des deux reins.

Sur des coupes on démontra que la sclérose pulmonaire avait une tendance marqueé à former des nodules qui correspondaient aux manifestations de la sclérose tubéreuse d'autres organes, et que de petites plages, de 1 à 2 millimètres de grandeur, avec des parois alvéolaires épaissies et les accumulations de pigment, étaient le substratum anatomique de l'image radiologique de granulie.

L'auteur montre que cette affection pulmonaire (la sclérose tubereuse du poumon), les altérations au niveau des os des doigts, ainsi que les tumeurs des reins et la sclérose tubéreuse du cerveau appartiennent toute à l'image pathologique hétérogène de la sclérose tubéreuse.

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PRIMARY BONE SARCOMA[1]

The Norwegian Radium Hospital's Material 1932—1937

by

Reidar Eker and *Erik Poppe*

Introduction. Material. Classification.

Primary bone sarcomata are of considerable medical interest, not least because the most important of them, the osteogenic sarcomata, preferably affect young individuals and take an extremely malignant course. There are conflicting opinions as to the best method of treatment, especially as to the use of roentgen therapy on the various types of bone sarcoma. Primary bone sarcomata are uncommon tumors. At the Norwegian Radium Hospital (N.R.H.) a total of 3795 patients with malignant tumors have been treated since its opening in May 1932 until September 1937. Among these there were 42 cases of primary bone sarcoma, i. e. these comprise 1.1 % of the hospital's material of malignant cases in this period.

The following is a brief compilation of the N.R.H.'s material of primary bone sarcoma in the above mentioned period, the controls were concluded in May 1941. The number of cases is so small that the material has no independent statistical value, but it reveals certain interesting facts, especially with reference to the effectivity of roentgen therapy on the various forms of sarcoma.

All the material is recorded, the pathological data by the hospital's former prosector, Professor L. KREYBERG M.D., and our diagnoses do not deviate in principle from these records although we are personally responsible for the classification used here.

In this compilation we have only used cases where we regard the diagnosis as absolutely reliable, 14 uncertain cases are not included in

[1] Submitted for publication Oct. 28, 1941.

this material. There are biopsies from 32 of the 42 cases. In the other 10 the diagnosis has been made on the basis of the clinical and roentgenological findings and the clinical progress has in most cases supplied the proof of the correctness of the diagnosis. Like all of the hospital's patients, all of these were controlled clinically and roentgenologically at regular intervals after the conclusion of the treatment. One patient however was not controlled after the conclusion of the treatment and this case is not included in the final result.

For the microscopical examination, besides the usual hematoxylin-eosin staining, a number of other special staining methods have been used where this was found necessary (staining according to the methods of VAN GIESON, BIELSCHOWSKY, LAIDLAW, thionine staining).

The different forms of primary bone sarcoma have been described often since Virchow, but under varying designations and with varying interpretations. There is still disagreement as to the interpretation of the histological picture. The lack of knowledge of the etiology and histogenesis of the tumors is responsible for the fact that the classification of bone sarcomata is unsatisfactory and far from uniform. All attempts at classification are based on histogenesis. BORST (1924) made a purely histogenetic classification. Fundamental work in this field has been done by KOLODNY (1927) and TAVERNIER (1927) and GESCHIKTER and COPELAND (1931, 1936) in their well known publications have made a classification based on the embryology of the bones. In 1920 the Committee of the Registry of Bone Sarcoma of the American College of Surgeons was founded on the initiative of CODMAN, BLOODGOOD and EWING. The results of this registry published by a number of American investigators (BLOODGOOD, PHEMISTER, MCREYNOLDS and many others) are of such great significance that no attempt at the classification of bone sarcomata can ignore the basis which has been formed by this work. A number of suggestions for classification have been given by the Codman registry and have been used in a number of Scandinavian publications (MAGNUSSON 1931, ROSCHER 1933, ENGELSTAD 1933, DAHL 1937 inter al.) and latest by EWING in 1939.

Only some of the forms in EWINGS classification appear in our material. The clinical, roentgenological and pathological aspects of the various bone sarcomata are well known. We shall limit ourselves to remarks which are necessary in regard to types which are of interest in the following.

The Codman registry has always used the term osteogenic sarcomata, introduced by EWING in 1920, in a very broad sense and including malignant tumors »derived from tissue destined to form bone or originating in bone». They therefore include tumors of widely varying histological structure and with differing clinical and roentgenological characteristics. Thus the periosteal fibrosarcomata are a well defined group of tumors,

probably originating in the fibre layer of the periosteum. KOLODNY as well as GESCHICKTER and COPELAND distinguish the periosteal fibrosarcomata from the osteogenic sarcomata, and in our classification we have found this to be the most practical. Since RIBBERT, the chondrosarcomata are recognized as a distinct group, consisting chiefly of atypic cartilage tissue. In the earlier suggestions for classification in Codman's registry these tumors are registered as osteogenic sarcomata. PHEMISTER (1930) emphasized their histological, clinical and roentgenological characteristics and suggested that they be placed in a group of their own, and this has been carried out by EWING in his latest classification. The chondrosarcomata exhibit widely varying clinical malignancy (EWING 1939). GESCHICKTER and COPELAND distinguish primary myxo-chondrosarcomata from secondary chondrosarcomata, a distinction which was adopted by HELLNER in 1938. The former occur in young individuals and take a very malignant course and are attributed to the osteogenic sarcomata. The secondary chondrosarcomata, which develop from preexisting chondromata, take a slower and less malignant course and occur in an older age group. ROUSSY and OBERLING reserve the term chondrosarcoma for the highly differentiated forms, largely corresponding to GESCHICKTER and COPELAND's secondary chondrosarcomata. In our material the different cases fall naturally into the groups primary and secondary chondrosarcomata, the latter group representing the highly differentiated forms. The distinction of myxo-chondro-osteosarcomata (RIBBERT) as a special group which generally corresponds to GESCHICKTER and COPELAND's primary myxo-chondrosarcomata also seems justified.

Distinction between peripheral (periosteal) and central (medullary) osteogenic sarcomata is generally used. Since VIRCHOW described the sclerosing form this type has been included in the common nomenclature. GESCHICKTER and COPELAND distinguish osteolytic and osteoblastic sarcomata according to the amount of bone tissue in the tumors. The deposition of calcium is undoubtedly due, as EWING (1939) points out, both to the degree of malignancy of the tumors and a number of unknown physiological factors. GESCHICKTER and COPELAND's statistical data (1931) show such a clear difference in age group, localization and prognosis between the two groups that classification in osteoblastic and osteolytic forms is undoubtedly practical. For the other groups our classification is based completely on the Codman registry. However we use the more neutral term Ewing's sarcoma instead of diffuse endothelioma.

Our material of 42 cases thus falls into the following groups:

I. Osteogenic series.

a. Osteoblastic (including sclerosing)	18 cases
b. Osteolytic	4 cases

II. Chondroma series.
  a. Chondrosarcoma . . . . . 7 cases
  b. Myxo-chondro-osteosarcoma . . . . . 3 cases
III. Ewing's sarcoma . . . . . 5 cases
IV. Periosteal fibrosarcoma . . . . . 4 cases
V. Non-classifiable sarcoma . . . . . 1 case

A complete compilation of the data on age and sex as well as the duration of the symptoms and the result of the control examinations is given in Tables 1, 2, 3 and 4. We refer readers to these tables in connection with the following sections. Our 1 non-classifiable case which presented the picture of a slightly differentiated »round cell sarcoma» in the clavicula, resulted in death very quickly and will not be discussed in more detail.

Radiation technique.

On all of the patients treated, protracted fractioned roentgen therapy was used except for 1 patient (myxo-chondro-osteosarcoma) who was given teleradium therapy for the tumor.

Roentgen treatment was usually administered over several fields, in those cases where the tumor was localized to the extremities, 3 fields were used. Other conditions of radiation: 175 k.v., 4 m. amp., filter: 2 mm. Cu. + 0.5—1 mm. Al., skin target distance: 60 cm. Radiation intensity about 5 r. per minute. 200—450 r. pro dosi measured in air. Epidermicide doses were used so that at the conclusion of the treatment there was a desquamating or exudative epidermitis. The average total dose per field was about 4000—4500 r. at the conclusion of the series of treatments. When using 3 fields the total dosage is thus 12000—13500 r. In those cases where it was possible to irradiate 1 or 2 fields only, the total dosage per field was usually slightly higher.

In some cases a new series of treatments was given when the reaction after the first series had passed, i. e. after about 3—4 months. This was done even when the patient did not have definite clinical symptoms of progression of the process. In the second roentgen series the total dosage per field has been about 2000—3000 r. per field, i. e. about half the dosage of the first roentgen series.

The 1 case which was treated with teleradium for a primary tumor is from the hospital's first year, this kind of treatment has not been used since for bone sarcoma.

I. Osteogenic sarcoma.

The osteogenic sarcomata form the largest group in this material with 22 cases. Of these 18 are classified as osteoblastic, of which 5 belong

to the sclerosing form of osteogenic sarcoma. There were 4 of the osteolytic form.

With reference to age grouping and localization, the nature and duration of the symptoms, our material is characteristic, and the numerical values fall within the limits given in more extensive statistical compilations (e. g. GESCHICKTER and COPELAND 1939). Table 1 shows, in spite of the small numbers, that there is a clear connection between the form of the osteogenic sarcomata and the age of the patient. The average age for the osteolytic sarcomata is 40 years, for the osteoblastic 24 years, while the oldest patient with the sclerosing form was 21. The wide age variation within the osteolytic group indicates that the development of this form is not dependent on the age of the patient alone.

Table 1.

Age and sex distribution

		Sex ♂	Sex ♀	Average age	Age variation
Osteogenic sarcoma	osteolytic	2	2	39.8	16—55
	osteoblastic	5	8	24.2	12—52
	sclerosing	2	3	17.0	12—21
Chondroma series	myxo-chondro-osteosarcoma	2	1	26.3	14—45
	chondro-sarcoma	4	3	40.6	24—63
Ewing's sarcoma		3	2	20.6	12—36
Periosteal fibroblastic sarcoma		2	2	31.2	15—52
(One non-classifiable case disregarded.)					
Total		20	21		

The osteoblastic sarcomata showed the following localization of the primary tumor:

os ileum	1 case
femur diaphysis (metaphysis free)	5 cases
distal femur metaphysis	5 cases
proximal tibia metaphysis	5 cases
proximal fibula metaphysis	1 case
proximal humerus metaphysis	1 case
total	18 cases

The osteolytic sarcomata showed the following localization:

Distal radius meta- and epiphysis	1 case
Distal femur metaphysis	2 cases
Tibia diaphysis	1 case

The localizations are thus characteristic as 13 out of 22 are localized to the metaphysis around the knee joint. In 12 of 22 patients there is

information of trauma in the region where the tumor later developed. The injuries were said to have taken place from a couple of weeks until about 2 years before the onset of the symptoms, but in only 5 cases were there continuous symptoms which took the form of pains and/or reduced motility. The duration of the symptoms before the first treatment is presented in Table 2. The average duration is from 3 to 5 months, varying from 1 to 10 months. There is no significant difference for the various forms. The most pronounced symptoms were pain and swelling. 15 of the patients said that the pains came first and 12 of these said that they later noticed swelling. 4 of the patients had only noticed a lump or swelling and 3 said that they first noticed a swelling and had pains afterward. In about $^1/_3$ of the patients the discovery of a tumor or swelling was the first symptom.

Table 2.

Duration of symptoms

		Number	Average duration of symptoms before 1st admission to or treatment in hospital		Duration of symptoms before the 1st roentgen treatment	
			Average in months	Variation	Average in months	Variation
Osteogenic sarcoma	osteolytic	4	5.5	3— 8	5.5	3— 8
	osteoblastic	13	4.3	1—10	10.1	3—42
	sclerosing	5	3.4	1— 6	4.1	1— 6.5
Chondroma series	myxo-chondro-osteosarcoma	3	6.3	2—11	7	3—12
	chondro-sarcoma	7	19.4	6—36	28.3	7—60
Ewing's sarcoma		5	7.5	5—12	8.5	5—13
Periosteal fibroblastic sarcoma		4	12.5	6—24	13.1	8—24
(One non-classifiable case disregarded.)						

The general condition of 10 of the patients was good when admitted to the N.R.H., in the others it was less satisfactory or poor. 5 of the patients had fever on admission.

In all of the patients not radically operated, extensive, destructive, more or less osteoblastic processes could be demonstrated roentgenologically at the time of admission. In 9 cases the process was found to be localized peripherally in the bone, all of them osteoblastic forms. In 2 cases, of which 1 was osteolytic, there was central localization. In 11 cases the tumor included the entire cross-section of the bone, the other 3 osteolytic forms were in this category.

3 of our patients are alive and healthy more than 5 years after the first treatment, (Table 3), while 4 exceeded the 5 year limit. The average length of life of those patients who died is not quite 21 months after the first treatment or a little more than 25 months after the onset of the symptoms. Prognosis for the osteogenic sarcomata is dependent on a number of factors which in part also determine their operability. Our surviving patients do not differ from the others with respect to age, the duration of the symptoms before treatment, or the localization or size of the tumor, but these factors cannot be evaluated numerically in our limited material.

Table 3.

Length of Life, expressed in years after admission to The Norwegian Radium Hospital.

	Died whithin (years)								Alive after more than (years)						
	½	1	2	3	4	5	6	7	3	4	5	6	7	8	Total
Osteogenic sarcoma	2	6	7	—	1	1	1	—	—	—	1	—	1	1	21
Myxo-chondro-osteosarcoma . . .	1	1	—	—	—	—	—	—	—	1[1]	—	—	—	—	3
Chondrosarcoma	—	—	1	1	1	—	—	1	—	2[2]	—	1[3]	—	—	7
Ewing's sarcoma	2	1	1	—	—	—	—	—	—	1	—	—	—	—	5
Periosteal fibroblastic sarcoma . .	2	1	—	—	—	—	—	—	—	—	—	—	1	—	4
Non-classifiable sarcoma	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Total	8	9	9	1	2	1	1	1	—	4	1	1	2	1	41

[1] Now has lung metastases.
[2] One patient is symptomfree, the other is not cured.
[3] Not cured.

9 out of 41 patients are alive from 4—8 years after admission to the N.R.H., 32 patients died from 3 months to 7 years after admission.

The greatest interest is concentrated on the prognostic significance of the tumor's histological type and the choice of therapy. It is claimed that prognosis is somewhat better for the sclerosing osteogenic sarcomata than for the other types, (GESCHICKTER and COPELAND 1931, MCREYNOLDS 1938: about 10 % 5 years cure). BEHRING's material (1930) and ROSCHER's (1933) are difficult to evaluate as they do not give data on the different tumor groups with regard to the course of the disease. On the basis of the Mayo Clinic's material, MEYERDING (1938) regards the determination of the type of malignancy to be the most important method of classification, as the various types of malignancy show various prognoses and also indicate various kinds of treatment. SIMMONS (1939) distinguishes fibrous, chondromatous and anaplastic types of the osteogenic sarco-

mata and finds considerably higher mortality for the less differentiated types than for the more differentiated types.

Evaluation of clinical malignancy on the basis of the histological picture however, meets with difficulties in the case of the osteogenic sarcomata. This is partly due to the fact that different regions of the tumor are not always uniform in appearance (KOLODNY 1927). Evaluation can therefore be made only on the basis of abundant biopsy material.

In our material of osteogenic sarcoma there are biopsies from 18 patients of which 16 are from cases with the osteoblastic forms and 2 from osteolytic forms. The result of the microscopical examination is described in connection with a description of these cases below 1 patient with an osteolytic sarcoma is still alive after more than 7 years, but the biopsy, taken after considerable roentgen doses, was negative for tumor tissue. The microscopical findings from the 2 surviving patients with osteoblastic sarcoma are of interest. They both showed a tumor tissue rich in cells with clearly atypic nuclei but there were no monstrous forms (see Figs. 4, 7 and 8 and the description on p. 398 and 399). hTe microscopical pictures indicate a moderate malignancy. The other biopsies from cases with osteoblastic sarcoma all showed the varied picture usually encountered in osteogenic sarcomata and none afforded any diagnostic difficulties. There were varying signs of bone destruction and all showed signs of new formation of atypic bone tissue, some via hyalinized connective tissue, some via osteoid tissue. In 7 there was atypic cartilage. Cartilage in large quantities was found in only 1, in this preparation there were also unusually abundant mitoses. For the most part the tumor tissue was rich in cells, consisting of spindle shaped and polygonal cells with pronounced hyperchromatism and variation in nuclear size. In all, except one where the biopsy was very small, monstrous giant tumor cells could be demonstrated. Blood vessels were very numerous in 2 although they were not of the teleangiectatic form. But in no less than 10 it was found that the tumor cells lined the blood sinuses. The biopsy material was abundant in 12 cases (some characteristic pictures are presented in Figs. 1 and 7). The material is too limited to form the basis of an evaluation according to BRODER'S method. But the biopsies from all of the patients who died, will, according to the histological picture, be evaluated as polymorphous, little differentiated forms. The microscopical picture from the patients who died after passing the 5 year limit and from the one who died after passing the 6 year limit does not however differ from the others. From one of the patients with osteolytic sarcoma the only biopsy was from a tongue metastasis. Here there were very polymorphous atypic spindle cells which formed a tumor tissue rich in cells. The biopsy supported the clinical and roentgenological diagnosis.

15 of the 22 patients had already been operated before admission to the N.R.H.: test excision, local extirpation of the tumor, resection or amputation (Table 4). There has thus been great variation in the treatment, a frequent feature of material of this kind, partly due to operability factors, such as early metastases, partly due to the fact that the patients or their relatives object to any mutilative operative treatment. As is known there is no absolute agreement as to methods of treatment and the effectivity of roentgen therapy on osteogenic sarcoma. The earliest possible operative treatment is generally claimed to be the »method of choice», eventually with subsequent roentgen therapy. (GESCHICKTER and COPELAND, EWING, KOLODNY, BEHRING, ROSCHER, HELLNER.) The results of FERGUSON'S (1940) control examinations of 400 cases of osteogenic sarcoma stand in contrast to this. By »late» amputation, i. e. amputation performed more than 6 months after the onset of the symptoms, he obtained 37 % 5 year cures. »Early» amputation, i. e. amputation performed within 6 months after the onset of the symptoms gave only 4 % 5 year cures. The result was not due to the difference in the histological degree of malignancy. Where the histological picture was less malignant the figures for 5 year cures for the »late» and »early» amputated groups were 41 % and 14 % respectively. Roentgen treatment before amputation seemed to improve the results of early amputation (23 % cure) while preoperative irradiation seemed to have no effect when late amputation was performed. FERGUSON therefore warns against early amputation and recommends that resection of the tumor be performed first, preferably with transplantation of bone and/or preoperative roentgen therapy. No one recommends roentgen therapy exclusively where the case is regarded as operable. However a number of good results with roentgen

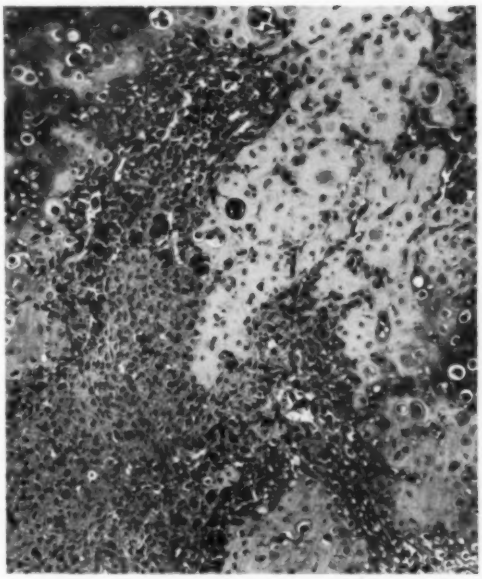


Fig. 1. L. R. ♀ Aged 16. Osteoblastic osteogenic sarcoma in proximal fibula metaphysis. Mors 2 yrs. after 1st treatment. Histologically high degree of malignancy. × 100.

Table 4.

Treatment.

	Treatment	Duration of symptoms before 1st treatment in months	Died within (years) after 1st treatment					Alive more than (years) after 1st treatment				
			3	4	5	6	7	4	5	6	7	8
Osteogenic sarcoma . . . Total 21.	Exartic. or ampnt.	4—5	7	—	—	—	—	—	—	—	—	—
	Roentgen + amputation .	2—10	2	1	1	1	—	—	—	—	1	—
	Local surgery + roentgen . .	1—12	5	—	—	—	—	—	1	—	—	1
	Roentgen[1] . . .	4—6	6	—	—	—	—	—	—	—	—	—
Chondroma series . . Total 10. — Myxochondroosteosarcoma . . Total 3.	Amputation . .	6	1	—	—	—	—	—	—	—	—	—
	Rtg. + radical surgery. . . .	2—11	1	—	—	—	—	1[2]	—	—	—	—
Chondrosarcoma . . Total 7.	Local surgery + roentgen . .	6—36	1	—	—	—	1	1[3]	—	1[3]	—	—
	Roentgen[1] . . .	6—30	1	1	—	—	—	—	1	—	—	—
Ewing's sarcoma . . . . . Total 5.	Roentgen[1] . . .	5—12	4	—	—	—	—	—	1	—	—	—
Periosteal fibroblastic sarcoma . . . . . Total 4.	Roentgen[1] . . .	6—24	3	—	—	—	—	—	—	—	1	—

1 disregarded.

[1] Osteotomy for biopsy was performed on some of these patients.
[2] Now has lung metastases.
[3] Alive with symptoms.

therapy alone have been reported. (TAVERNIER, HOLFELDER inter al.) LANGENSKIÖLD (1931) states that in consideration of the poor results obtained with operative treatment on bone sarcoma it seems fully justified to try other kinds of treatment. ENGELSTAD (1933) believes there is good reason to use roentgen treatment preoperatively in osteogenic sarcoma and that this should be done in cases where the diagnosis has not been verified histologically.

In our material primary amputation and exarticulation were carried out on 2 patients respectively without preoperative roentgen therapy. They were operated 6 months (exarticulatio femoris) and 8 months (amputatio femoris) respectively after the onset of the symptoms. Both of them died of lung metastases 1 and 9 months respectively after the operation. On one patient amputation was performed 5 months after the appearance of the first symptoms, on 5 after 11—13 months. All were first given roentgen treatment with doses from 4800 r. to 18000 r. distributed over 3 fields. 5 of these 6 patients died. Their average length of

life after the onset of the symptoms was a little over 36 months, the average length of life after the first treatment was 31 months and after amputation 25 months.

The 6th patient who was given preoperative roentgen therapy and on whom amputation was performed 11 months after the onset of the symptoms is alive and symptom free 7 years after the first treatment.

2. 3.

Figs. 2 and 3. J. S. ♀ Aged 61. Case I. Osteolytic osteogenic sarcoma in tibia diaphysis. Alive and symptomfree 7 years after 1st treatment.

1) J. S. 61 year old woman. For 3 months before admission had symptoms in the form of pains and a slightly tender swelling over the left tibia just distal to the knee joint. Previously untreated. On admission the patient's general condition was good. Over the antero-medial surface of the tibia a 4 × 3 cm. hard, even protrusion, slightly sensitive to pressure could be palpated. Lues reactions were negative. A roentgenogram of the crus showed a poorly defined destructive process in the tibia diaphysis, 2.5 × 5 cm. in extent with penetration of the corticalis on the medial side (Figs. 2 and 3). R.: Osteolytic form of osteogenic sarcoma. Roentgen treatment was administered on 3 fields over the tumor, the total dosage was 18 000 r., other conditions of radiation as described on p. 390. On the conclusion of the roentgen therapy osteotomia tibiae was performed in order to obtain material for histological examination. This revealed only tissue destroyed by irradiation and no tumor tissue could be demonstrated. 6 months after the conclusion of the roentgen treatment the patient had severe pains and oedema in the limb and motility was abnormal corresponding to the pathological process in the tibia. A roentgenogram at this time showed a fracture through the cavity with dislocation of the fragments. Amputation was then performed slightly distal to the middle of the femur. Histological examination of the amputation preparation revealed only irradiated tissue, no tumor tissue. The operation preparation and the result of the microscopical examination are described in detail by DAHL (1935, Strahlentherapie 54, p. 44) to which we refer the reader for details. The roentgenological diagnosis osteogenic sarcoma is regarded as certain in this case. It is probable that the large roentgen doses have destroyed the tumor tissue and also caused a roentgen injury to the normal bone tissue causing inhibition of its regenerative capacity and possibly contributing to spontaneous fracture.

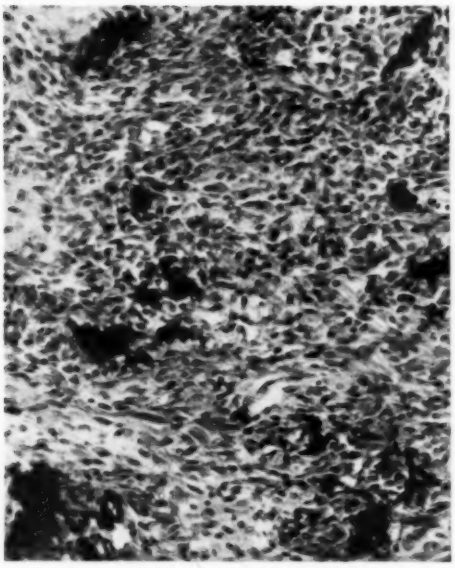


Fig. 4. J. F. ♂ Aged 24. Case 2. Osteoblastic osteogenic sarcoma in femur diaphysis. Histologically low degree of malignancy. Alive and healthy $5^1/_2$ yrs. after 1st treatment. × 200.

7 patients had been given local surgical treatment (extirpation or excochleation) before admission to the N.R.H. The operations were performed 1—12 months after the onset of the symptoms. All 7 patients were given post operative roentgen treatment. Two are alive and healthy after 5 and 8 years respectively.

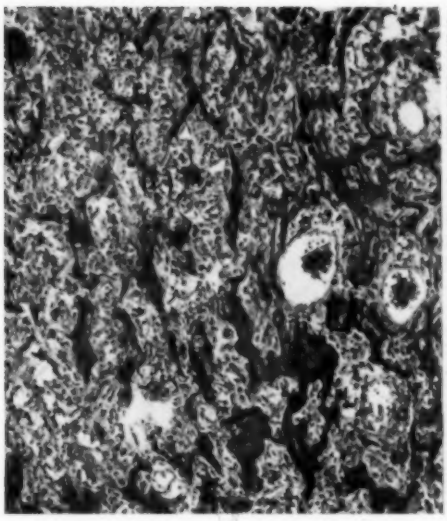
2) J. F. 24 year old ♂. In October 1934 a violent injury to the lateral side of the right thigh. Later periodical pains and after 2 months he had to stop work because of the pains and was unable to work from this time on. In March 1935, about 6 months after the onset of the symptoms, osteotomy with excochleatio was performed. A large biopsy was taken. The microscopic examination revealed a spongy bone tissue with pronounced signs of destruction of the bone trabeculae. Between these there is abundant cell-rich tumor tissue largely composed of spindle shaped and polygonal cells (Fig. 4). The nuclei show pronounced hyperchromatism and variation in size but usually to a moderate degree and no giant tumor cells are seen. There are few mitoses. There are several diffuse calcium accumulations and in the periphery of some of these there is newly formed atypic bone tissue. No cartilage. In the periphery of the tumor tissue there is abundant reactive newly formed bone with regular structure. A few giant cells of the foreign body type. There are several large blood vessels and some of these are directly covered with tumor cells. Diagnosis: osteogenic sarcoma, probably of a low degree of malignancy. 2 months after the operation the patient showed signs of recidivating tumor and 5 months after the operation he was admitted to the N.R.H. On admission he complained of violent pains in the thigh. He had no fever and his general condition was good. A roentgenogram of the femur (Figs. 5 and 6) shows an 8 × 3 cm. large tumor which sits on the shaft of the femur like a mushroom. It consists of a fine network of bone trabeculae. Corresponding to the base of the tumor there is destruction in the shaft of the femur 1 × 3 cm. in extent. Distal to the tumor there is a pronounced periosteum reaction with an indication of lip formation. The entire process, including the thickening of the corticalis, comprises 17 cm. of the femur diaphysis. Roentgen treatment was administered against 4 fields, the total dose per field was 4000 r. When the reaction to this series of treatments had subsided a new series was given, this time against 3 fields, in all 2300 per field. The total dosage of the 2 roentgen series was thus 23000 r. A roentgenogram taken 5 years after the conclusion of the roentgen therapy shows increased calcium content, the process now has sharp, clean contours and the destroyed region of the femur shaft is now filled with bone tissue.

5.

6.

Figs. 5 and 6. Same patient as the preceding. Roentgenogram of the right femur before radiological treatment. Tumor size 8 × 3 cm., destruction of the femur shaft corresponding to the base of the tumor.

3) O. K. 14 year old ♂. In August 1932 »twisted» his right knee, followed by swelling and pains in the region of the knee joint. The swelling increased but the patient kept on his feet for about 1 month. In September 1932 he was hospitalized and a tumor the size of a goose egg was extirpated from the femur just proximal to the condylus lateralis. The microscopical examination (Figs. 7 and 8) revealed a tumor tissue rich in cells and vessels, consisting of spindle formed and polygonal cells. Clearly atypic nuclei with pronounced hyperchromatism and some mitoses. In the very extensive biopsy material only a couple of abnormally large eosinophilic cells with hyperchromatic irregular nuclei were found. New formation of atypic osteoid tissue and bone tissue varied somewhat in different regions but was usually moderate. There were remains of bone trabeculae and at one point there was a little island of atypic cartilage with a transition to osteoid tissue peripherally. Some large blood sinuses seemed to be directly coated with tumor cells. In some regions several giant cells of the foreign body type. No leucocyte infiltration. Diagnosis: osteogenic sarcoma. Probably of a low degree of malignancy. 2 months after the operation there was clinically and roentgenologically demonstrable recidive. On admission to the N.R.H. the patient complained of pains in the region of the knee joint,



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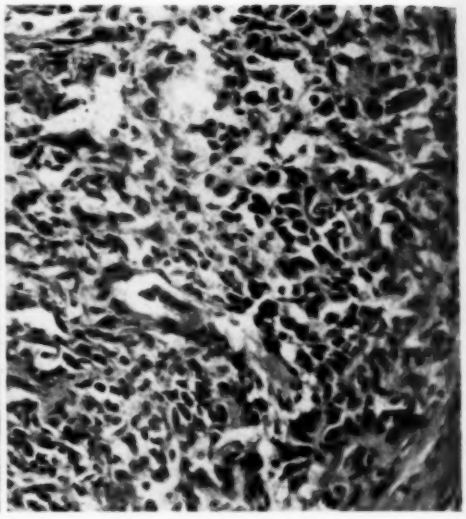


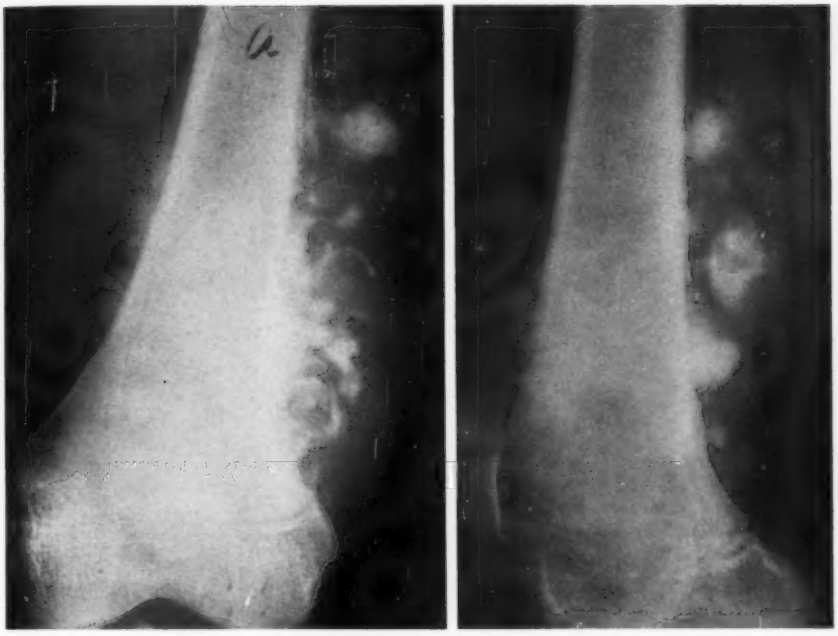
8.

Fig. 7. O. K. ♂ Aged 14. Case 3. Osteoblastic osteogenic sarcoma in distal femur metaphysis. Histologically low degree of malignancy. Alive and healthy 8 years after 1st treatment. × 100.

Fig. 8. Same patient. × 200.

he was subfebrile, general condition good. Roentgenogram of the right femur: (Figs. 9 and 10) in the distal femur metaphysis there is an osteoblastic destructive process which extends 15 cm. from the epiphysis line in a proximal direction. Spiculae and loosening of the periosteum with lip formation. Considerable soft tissue tumor sprinkled with calceous areas. No enlargement of the bone. Roentgen treatment was administered against the tumor on 3 fields, in all about 3000 r. per field. As soon as the roentgen therapy was begun there was rapid subjective improvement as the pains disappeared completely. A roentgenogram taken 3 months after the conclusion of the roentgen treatment shows increased calcium content both in the soft tissue tumor and in the bone, and the entire process has sharper contours. A roentgenogram taken 6 months after the conclusion of the roentgen therapy shows reduction of the calcified areas in the soft tissue, the process in the bone shows still sharper contours. Figs. 11 and 12 show the process 8 years after the conclusion of the roentgen treatment. The patient is alive and symptomfree after 8 years.

The number of patients is too small to provide the basis for any conclusions as to the value of the various operations, and in particular it does not permit taking a standpoint with regard to FERGUSON'S opinion. However the results do not contradict FERGUSON'S observations. It is possible that the histological type of the osteogenic sarcomata is one of the most important prognostic factors, a fact which is too little



9. 10.

Figs. 9 and 10. Same patient. Roentgenogram of right femur before roentgen treatment.

emphasized outside America. Two of our recovered cases (Cases 2 and 3) treated with local surgery and subsequent roentgen therapy undoubtedly illustrate the significance of the histological degree of malignancy of the osteogenic sarcomata. This result falls completely within the frame of MEYERDING's (1935) opinion that osteogenic sarcomata of a low degree of malignancy (I and II) can be treated by extirpation followed by radiological therapy. In all of the patients who died within the period of observation the biopsy showed a polymorphous, less differentiated tumor tissue with monstrous giant tumor cells; of these only 1 lived for 5 years but had lung metastases for over a year. In our case of osteolytic sarcoma who is alive and healthy 7 years after the first treatment (Case 1), the biopsy is negative for tumor tissue.

Where it is possible to determine the type of malignancy this may have a certain prognostic significance, and in a statistical evaluation of the results the histological type should be taken into consideration.

The effect of the roentgen treatment appears clearly in the material examined. For evaluation of the effect of roentgen treatment we would

11. 12.

Figs. 11 and 12. Same patient. The roentgenological picture 8 years after the conclusion of radiological treatment.

like to point out that in the entire material of operated cases there is only 1 patient (sarcoma fibulae, resection, mors 2 years after the operation due to lung metastases) who, on admission to the N.R.H. did not have demonstrable recidive or metastases. 3 patients had metastases on admission, the treatment of these cases was palliative.

When the roentgenological controls were made, objective improvement could be determined in the form of increased calcium content and sharper contours of the tumor shadow in 11 cases, while there was subjective improvement in 12 cases.

All 3 of the recovered cases are a striking demonstration of the considerable effect of roentgen treatment.

In 3 patients a considerable radiation effect on the tumor tissue was found in the amputation preparations. 2 of these cases, where there was apparently complete disappearance of the tumor after large roentgen doses, are described in detail by DAHL (1935). We would like to point out that in one of these preparations undestroyed tumor tissue was found in the bone outside the irradiated field, while apparently all tumor tissue

was destroyed within the irradiated field. This demonstrates the significance of the use of large fields. (MAGNUSSON 1931.) In the 3rd of these patients amputation was performed for an osteogenic sarcoma in the proximal tibia epi- and metaphysis. Amputation was performed 13 months after the onset of the symptoms and after preoperative roentgen treatment (dose 4500 r. distributed over 3 fields). In the amputation preparation after this comparatively small dose, rather extensive degenerative changes in the tumor tissue with pycnosis of the nuclei could already be observed although the tumor tissue was not destroyed. The patient died 5 years after the onset of the symptoms, a little over 4 years after the first treatment.

It is well known that roentgen may have a considerable effect on lung metastases from osteogenic sarcomata. 2 of our patients had lung metastases on admission. Roentgen treatment was administered to the lung metastases with excellent subjective and objective effect. The treatment was given against 3 fields, 200—350 r. pro dosi, total dose 3000—3500 r. per field. Other conditions of radiation: 175 k.v., 4 m. amp. Filter: 2 mm. Cu. + 1 mm. Al. Skin target distance: 50 cm. The patients lived 6 and 16 months respectively after the treatment of the lung-metastases.

In our opinion combined surgical and radiological treatment should be administered for osteogenic sarcomata. By beginning with radiological treatment a basis can be established for the tumor's radiosensitivity. If the tumor belongs to a type of low histological malignancy and proves to be rather radiosensitive there is a possibility that operation may be avoided or carried out with retention of the function of the limb. Our experience has shown the sclerosing form to be of low radiosensitivity. However in many cases it is very difficult, on the basis of control roentgenograms and the clinical picture, to judge the effect of radiological treatment until several months later, so that there may be uncertainty for quite a long time as to the effect of the treatment. This is undoubtedly one of the greatest difficulties in the way of the carrying out of the combined treatment. It is possible that one might be able to get more accurate data on the effect of the radiological treatment by taking a series of puncture biopsies of the tumor at a relatively early period. It is also possible that determinations of serum phosphatasis in cases of bone tumors which have been treated radiologically are useful in indicating the degree and permanence of the inactivation caused by the irradiation (WOODARD and HIGINBOTHAM 1937, 1941). No harmful effects of test excisions could be demonstrated in any of our cases of osteogenic sarcoma.

Prophylactic roentgen treatment of the lungs has been suggested in osteogenic sarcoma (PFAHLER and PARRY 1931, CAMPBELL, KOLODNY). We have no experience in this matter as we have never tried this method.

The reason for this is the great strain and the dangers which irradiation of the lungs would cause the patient. It would be necessary to irradiate both lungs in their entirety and with such large doses that the patients general condition might be unfavourably affected and irradiation changes might arise in the lungs.

II. Chondroma series

This group includes 10 cases. As explained in the introduction a distinction is made between myxo-chondro-osteosarcomata and chondrosarcomata. Within the latter group primary and secondary chondrosarcomata are distinguished. As appears from Tables 1 and 2 the average age of the patients and the duration of the symptoms vary in the different forms, and the secondary chondrosarcomata distinguish themselves from the other types by a considerably less malignant progress. Our material is so small that it is of interest only for the individual cases.

Only 3 cases belong to the first group, the myxo-chondro-osteosarcomata. One of these was treated by amputation and died of lung metastases 12 months ofter the operation. The 2 other cases were treated by combined surgery-roentgen. In both cases the tumor was only slightly radiosensitive, and roentgen treatment had no convincing effect.

The *chondrosarcomata* obviously belong to an older age group (Table I).

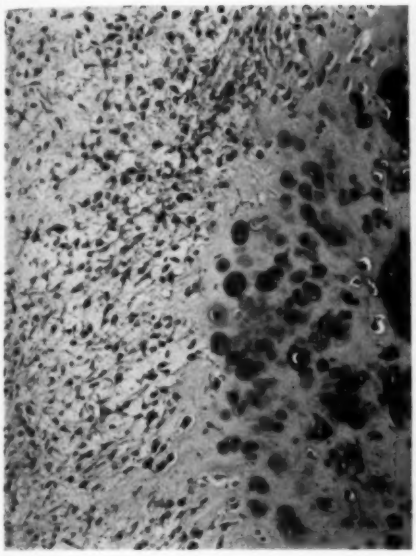
a) The secondary chondrosarcomata. 5 cases.

All of the patients had long hospital records (Table 2). There are biopsies from 3 of the 5 cases. Microscopy revealed moderately atypic cartilage tissue as the dominating type of tissue in all of them, a representative picture is reproduced in Fig. 14.

2 of the patients died respectively 7 and $3^1/_4$ years after the first treatment while 2 are still alive with symptoms 6 and 4 years after the first treatment, and 1 is alive and symptomfree 5 years after the first treatment (4). In 3 of the patients the chondrosarcomata developed secondarily from preexisting chondromata.

4) One of these patients in whom the chondrosarcoma developed secondarily from a chondroma was a 21 year old woman in whom there was roentgenologically demonstrated destruction of the corticalis corresponding to the base of a mushroomlike tumor proceeding from the medial side of the femur metaphysis. Biopsy: moderate atypic cartilage. Roentgen treatment in epidermicide doses caused rapid subjective improvement as the pains from which the patient had been suffering disappeared completely. The patient is alive and symptomfree 5 years after the first treatment. The tumor is still demonstrable. It seems unchanged in size but roentgenograms show considerably increased calcium content in the tumor and there are now no signs of destruction of the femur shaft.

Two patients had tumors in the callus after fractura costae and fractura fibulae respectively.



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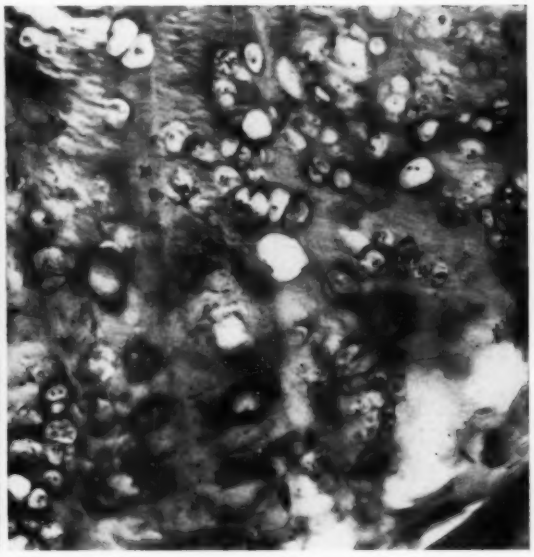


14.

Fig. 13. V. B. H. ♀ Aged 20. Myxo-chondro-osteosarcoma maxillae. Mors $3^1/_2$ months after 1st treatment. Radio-resistant. Histologically high degree of malignancy. × 100.

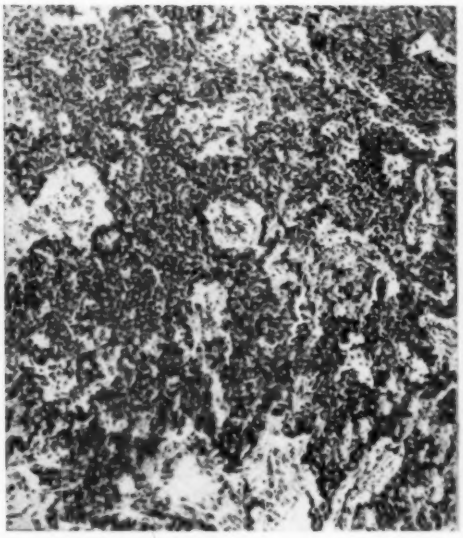
Fig. 14. M. O. N. ♀ Aged 41. Secondary chondrosarcoma in os pubis. Recurred twice after extirpation. Histologically low degree of malignancy. Patient alive with symptoms 6 yrs. after 1st treatment. × 100.

b) Primary chondrosarcomata. 2 cases. These show a much more malignant progress than the preceding group.

The patients were 24 and 44 years old, the tumors were localized to the os sacrum and costa respectively. Biopsies from both showed very cell rich tumor tissue with abundant atypic cartilage and many monstrous forms of tumor cells (Fig. 15). Roentgen treatment caused considerable subjective improvement in both cases and in the one case also demonstrable objective improvement as the calcium content of the tumor increased after treatment. Both patients died, 2 and 3 years respectively after the first treatment.

The cases of primary and secondary chondrosarcoma discussed above seem to elucidate the significance of the chondrosarcomata's differentiation for the prognosis.

While roentgen treatment had little or no effect on our cases of myxo-chondro-osteosarcoma, we were able to demonstrate subjective improvement in 5 of 6 cases of roentgen treated chondrosarcoma, and also objective improvement in 2. Sarcomata consisting of cartilage tissue are ge-



15. 16.

Fig. 15. A. H. ♂ Aged 24. Primary chondrosarcoma in os sacrum. Mors 2 yrs. after 1st treatment. Histologically high degree of malignancy. × 100.

Fig. 16. O. D. ♀ Aged 36. Case 5. Ewing's sarcoma; possibly primary reticulosarcoma. (Parker and Jackson.) Os ileum. Alive and healthy 5 yrs. after 1st treatment.

nerally regarded as being little sensitive to radiation and are treated operatively.

Radical operative treatment is applied to the less differentiated forms. The more differentiated forms show a tendency to recurrence after local operative treatment and post operative roentgen treatment in large doses is advisable.

III. Ewing's sarcoma

Since EWING in 1921 described a form of bone sarcoma which he called endothelial myeloma and later diffuse endothelioma, this form of sarcoma has been described in numerous articles. (Among the Scandinavian publications on this subject we can mention ENGELSTAD, KNUTSSON, MAGNUSSON, WELIN, JENS NIELSEN.)

Our material includes 5 cases, 3 women and 2 men. The average age is 20 years. The duration of the symptoms before first treatment at the hospital was on the average 7.5 months.

Localization:	os ileum	3 cases
	os sacrum and os ileum	1 case
	femur meta- and diaphysis	1 case

As is well known, EWING's sarcoma is extremely sensitive to roentgen. ENGELSTAD, JENS NIELSEN, MAGNUSSON, J. STRUTHERS FULTON and KOLODNY recommend roentgen treatment exclusively. Most however, recommend combined surgical and radiation therapy, among others COLEY, HELLNER, GESCHICKTER and COPELAND.

All of our cases were given roentgen treatment only. 4 patients died from 3 to 14 months after the first treatment. There were biopsies from 3 of these. The patient from whom there was no biopsy presented a very characteristic clinical and roentgenological picture and died 3 months after the first treatment. All of the biopsies showed the well known characteristic picture. 3 of these patients showed clinically and roentgenologically demonstrable improvement and the improvement began during the course of the roentgen treatments.

A post mortem was performed on a 24 year old woman. The patient had been given a roentgen dose totalling 4500 r. on a field over a tumor in the os ileum. At the post mortem no trace of tumor tissue was found in the os ileum but there were extensive lung metastases. One of our patients is alive and symptom free after 5 years:

5) O.D. 36 year old ♀. After having had pains in the region of the left hip for 12 months the patient was admitted to hospital. A large tumor with an eneven surface was found corresponding to the left os ileum just outside of the articulatio sacro-iliaca. Osteotomy was performed to obtain material for histological examination. Microscopy revealed a cell-rich, uniform tumor tissue with tightly packed round-oval cells (Fig. 16). No intercellular substance, some tendency to pseudo-rosette arrangement. The nuclei were round or oval and showed marked variation in size and chromatin content. There were no giant cells. Sparse mitoses. The stroma consisted of narrow strips of connective tissue, no lymphocyte infiltration, blood vessels fairly abundant. Silver preparations were negative for argentophilic fibrils. The tumor tissue infiltrated solid connective tissue. Diagnosis: Ewing's sarcoma probable.

On admission to the N.R.H. the patient complained of pains. She was afebrile and her general condition was good. On the posterior part of the os ileum a hard tumor was palpable, almost as large as a grapefruit and firmly attached to the os ileum. Roentgen examination revealed a destructive process in the os ileum and the adjacent part of the os sacrum about 4 × 7 cm. in extent. Upward there was penetration of the corticalis with periosteum reaction. Calceous spots, which were interpreted as signs of reactive new bone tissue were found among the destruction foci. The contours against the surrounding bone were not clear. Roentgen treatment was given against 2 fields over the tumor, the total dose on each field was 5700 r. The palpable tumor rapidly decreased in size during the course of the treatment and at its conclusion the tumor was no longer palpable, the patient was also soon relieved of her pains. When the reaction to the first series of treatments had subsided a new series was given, this time 3000 r. on each field. The total roentgen dose in the 2 series was thus 17400 r. The patient is alive and healthy 5 years after the conclusion of the treatment.

This case exhibits a series of remarkable features. It is striking that on admission to the N.R.H. one year after the onset of the symptoms the patient had no general symptoms of any kind. She was afebrile and her general condition was good which is unusual for patients with EWING's sarcoma. Nor was the histological picture characteristic. The tumor however was highly radiosensitive and the roentgenological picture indicated that this was a case of EWING's sarcoma.

PARKER and JACKSON (1939) have distinguished a tumor group »primary reticulum cell sarcoma of the bone». The histological picture as described for these tumors shows great similarity to that found in our case as well as the clinical peculiarities. These tumors also give a better prognosis than EWING's sarcoma. The histogenesis of EWING's sarcoma is unknown and there are several contradictory theories (cf. MELLNICK 1933, EWING 1933). OBERLING and RAILEANU's (1932) interpretation that Ewing's sarcoma is a reticulosarcoma is steadily gaining ground. It is possible that there are variants of more or less differentiated forms. Our case may possibly belong to the type described by PARKER and JACKSON.

There are conflicting opinions as to whether osteotomy for diagnostic purpose should be performed on suspicion of Ewing's sarcoma. HELLNER recommends explorative section and claims that this is not harmful when performed lege artis; LANGENSKIÖLD, MEYERDING, NIELY, ROGERS and others are of the same opinion. SCHINZ advises against test excision unless radiation therapy has first been given, this point of view is shared by ENGELSTAD among others. In 4 of our patients osteotomy had been performed before admission to the N.R.H. in order to obtain material for histological examination. In 2 of these cases a severe ulceration which would not heal developed at the place of operation. Both of these patients became increasingly marasmic and died 7 and 3 months respectively after the osteotomy. In one of the cases post mortem was performed as mentioned above and it was found that all the tumor tissue at the site of the primary tumor was destroyed but there were extensive lung metastases. It cannot be excluded that the explorative excision in these 2 cases can have had a harmful effect, but this conclusion has no statistical basis. In the other 2 patients the osteotomy did not lead to any demonstrable complications.

In our opinion EWING's sarcoma should be treated radiologically. This point of view has previously been stated from the N.R.H. by ENGELSTAD (1933). The same opinion is held by MAGNUSSON, KOLODNY, JENS NIELSEN, J. STRUTHERS FULTON. Combined surgical and radiological treatment is recommended by CAMPBELL, COLEY, GESCHICKTER and COPELAND, HELLNER and others. The prognosis is poor both with operative and roentgenological treatment. Use of the latter at least avoids

the mutilation which results from operative treatment. Metastases should be treated with radiation. CAMBELL recommends prophylactic lung irradiation.

IV. Periosteal fibrosarcoma

In our material there are only 4 cases belonging to this group, 2 women and 2 men, average age 31. As appears in Table 2, the average duration of the symptoms before the first treatment was decidedly longer than for the osteogenic sarcomata.

Periosteal fibroblastic sarcoma should be treated with a combination of surgery and irradiation, the surgical treatment is considered the most important in this form of tumor. Resection of the tumor followed by radiation therapy is a procedure which seems rational.

SUMMARY

41 of 42 cases of primary bone sarcoma treated in the Norvegian Radium Hospital from 1932 to 1937 are compiled. Biopsies exist from 32 of the cases and the diagnoses are considered reliable for all of the cases. The classification and main results are presented in tables, and the surviving cases described in the text. 6 of the 42 patients were still alive at the end of the period of observation, i. e. a five-year cure in nearly 15 per cent.

3 out of 22 patients suffering from *osteogenetic sarcoma* were alive from 5 to 8 years after the first treatment. 2 of these cases showed a histologically low degree of malignancy. 2 cases treated with preoperative roentgen and amputation lived a little over 5 years after the first treatment. Combined preoperative roentgen treatment and surgical treatment is suggested for osteogenic sarcoma. In 4 out of 5 cases of *secondary chondrosarcoma* an convincing palliative effect was obtained and also an objective effect in 2 cases. Surgical treatment with postoperative radiological treatment is recommended for this group of tumours.

1 of 5 patients with *Ewing's sarcoma*, treated exclusively with roentgen, is alive and without symptoms 5 years after the last treatment. Radiological treatment is suggested.

In *periosteal fibroblastic sarcoma* surgical operation and postoperative roentgen are recommended.

ZUSAMMENFASSUNG

Es werden 41 von 42 Fällen primären Knochensarkoms zusammengestellt, welche in der Zeit von 1932 bis 1937 im Norwegischen Radiumkrankenhaus behandelt wurden. Sektionsbefunde liegen von 32 dieser Fälle vor, und die Diagnose wird für sämtliche Fälle als zuverlässig angesehen. Die Verteilung und die Hauptergebnisse werden in Tabellen dargestellt, und die überlebenden Fälle werden im Text beschrieben. 6 von den 42 Patienten befanden sich noch am Ende der Beobachtungszeit am Leben; d. h. es war eine fünfjährige Heilung in nahezu 15 Prozent zu verzeichnen.

3 von 22 Patienten mit *osteogenem Sarkom* waren 5—8 Jahre nach der ersten Behandlung noch am Leben. 2 von diesen Fällen zeigten einen histologisch niedrigen Malignitätsgrad. 2 Fälle, die mit präoperativer Röntgenbestrahlung und Amputation behandelt worden waren, lebten etwas über 5 Jahre nach der ersten Behandlung. Für das osteogene

Sarkom wird eine Kombination von präoperativer Röntgenbehandlung und chirurgische Behandlung vorgeschlagen. In 4 von 5 Fällen von *sekundären Chondrosarkom* wurde eine überzeugende subjektive Wirkung und in 2 Fällen auch ein objektiver Erfolg erzielt. Für diese Gruppe von Tumoren wird chirurgische Behandlung empfohlen.

1 von 5 Patienten mit *Ewingschen Sarkom*, welcher ausschliesslich mit Röntgenbestrahlung behandelt wurde, befindet sich noch 5 Jahre nach der letzten Behandlung am Leben und ist symptomfrei.

Bei *periostalem fibroblastischen Sarkom* werden chirurgisches Vorgehen und postoperative Röntgenbehandlung empfohlen.

RÉSUMÉ

Collationnement de 41 des 42 cas de sarcomes osseux primitifs traités à l'Hôpital Norvégien du Radium de 1932 à 1937. Il existe des biopsies de 32 d'entre eux, et les diagnostics sont considérés comme dignes de confiance pour tous les cas. Le classement et les résultats principaux sont présentés dans des tableaux, et les cas qui ont survécu sont décrits dans le texte. 6 des 42 cas étaient encore en vie à la fin de la période d'observation, ce qui représente une guérison après cinq ans dans presque 15 % de l'ensemble.

3 des 22 malades atteints de *sarcome ostéo-génique* étaient en vie de 5 à 8 ans après le premier traitement. 2 de ces cas présentaient histologiquement un faible degré de malignité. 2 cas traités préopératoirement par les Rayons Rœntgen, pris soumis à l'amputation, vécurent un peu plus de 5 ans après le début du traitement. La combinaison de la radiothérapie préopératoire avec l'acte chirurgical est proposée pour le sarcome ostéo-génique. Dans 4 des 5 cas de *chondrosarcome secondaire* on obtint un effet palliatif convaincant, et ce résultat était également constatable de façon objective dans deux cas. Le traitement chirurgical avec adjonction de radiothérapie postopératoire est recommandé pour ce groupe de tumeurs.

L'un des 5 malades atteints de *sarcome d'Erving*, après traitement exclusif par les Rayons Rœntgen, est en vie, et indemme de symptômes pathologiques, 5 ans après le dernier traitement. Le recours à la radiothérapie est suggéré.

Dans le *sarcome périostique fibroblastique* l'intervention chirurgicale et la radiothérapie postopératoire sont recommandés.

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(CHIEF: DOCENT HANS HELLMER, M. D.)

ON THE OCCURRENCE OF GAS IN GALLSTONES[1]

by

Bror Brodén

Radiate cracks or fissures in gallstones of the cholesterolpigment-calcium group have long been a known phenomenon, but it was not until relatively late that our knowledge of them was supplemented by the discovery that these fissures can contain gas *in vivo* (ÅKERLUND, KOMMERELL and WOLPERS, 1938). The gas can be observed radiologically in the gallbladder area in the form of star-shaped translucencies, the demonstration of which is obviously of great value in those cases of cholelithiasis in which the presence of concretions is not determinable by other radiological means.

Besides being in this way a valuable aid to the roentgen diagnosis of biliary calculus, this intravital occurrence of gas in gallstones has acquired significance for the question of the mode of fissure origin. ÅKERLUND assumes that the gas is produced by bacterial action on organic material and replaces the fluid in already existing chinks in the gallstone. According to a theory set up by KOMMERELL and WOLPERS the generation of gas is the primary factor. They consider that the gas formed in the gallstone diffuses out, and, as it is saturated with water vapour, this leads to desiccation and shrinkage and hence to the formation of fissures. If the generation of gas ceases, which may be due to the exhaustion of all the organic material available for this purpose, the gas last produced is absorbed and replaced by water. All gallstones containing fissures are thus considered to have passed through a phase of gas generation. That gas-containing concretions are so rarely encountered, is considered by KOMMERELL and WOLPERS to be due to the fact that as a rule the gas-generating phase is short in duration and passes rapidly over into the stage of fluid-filled spaces. The disintegration of gallstones to which the fissuring frequently leads may already take place, it is thought, during the gas-generating phase.

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It would seem to be impossible to decide by radiological methods of investigation whether gas formation is a necessary initial phase to fissure formation in gallstones. Certain data of a nature to serve as a base for what would admittedly be a rough statistical estimate of this question could be obtained if the duration of the gas-generating phase could be fixed. This, however, would require repeated roentgen examinations at short intervals of a very large series of cholelithiasis cases, a procedure that for various reasons cannot be put into practice. Follow-up examinations conducted for this purpose of cases that have happened to be encountered during the gas-generating phase do not, of course, allow of the latter's length being judged. One of the cases published by KOMMERELL and WOLPERS was examined three times. The first time no gas was observed, 28 months later there were distinct star-shaped translucencies, which were still demonstrable after a further six months. A case followed by ABEL presented an unchanged roentgen picture after two months.

Of the cases reported in the present paper, five were examined two or more times, care being taken, of course, to obtain comparable projections.

I. Male, 41 years. Previously quite healthy. Had two typical gallstone attacks during the 14 days preceding roentgen examination. A rise in temperature accompanied the second attack, during which the patient was admitted to the Surgical Clinic in Lund. Free from trouble five days before roentgen examination. Clinical diagnosis: Cholelithiasis + cholecystitis.

On cholecystography the gallbladder failed to fill. In the right hypochondrium, within an increased soft-parts density with a rounded lower pole, can be seen three calcareously dense ring shadows containing translucent star-shaped areas centrally as well as another one further up — gallbladder containing concretions with gas-filled fissures (Fig. 1).

The patient was not operated upon. On roentgen examinations (Plain films) respectively 6 and $7^1/_2$ months later (the patient had been free from symptoms in the meanwhile) all the stones had vanished. At a cholecystography following upon the latter of these examinations no excretion of the dye was obtained.

II. Woman, 60 years. Previously healthy. Abdominal pains of varying character and moderate rise in temperature during four days before admission to the Surgical Department of Falun Hospital. Clinical diagnosis: Cholelithiasis + Cholecystitis ac.

Cholecystography undertaken 14 days later showed failure of filling of the gallbladder. At the site of the latter were two ring shadows of calcification density, one of which had a distinct star-shaped translucency centrally (Fig. 2).

The patient was not operated upon. The cholecystitis slowly subsided.

A follow-up examination 1 year and 7 months later found the patient completely free from symptoms. On the plain picture taken of the gallbladder region the concretions distinctly visible at the first examination were now absent (Fig. 3). Two small opacities projected at the level of the tip of the 12th rib may represent calcareous stone fragments.

Both these cases, thus, presented pictures of gas-filled, fissured, calcareous concrements which could not be seen on roentgen examination

Fig. 1.

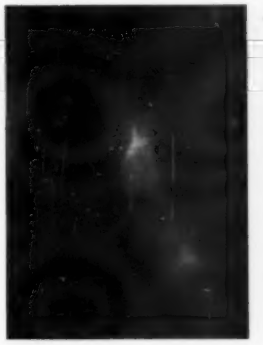

Fig. 2.

Fig. 3.

respectively 6 months and 1 year 7 months later. As in both cases the patients had been free from symptoms in the meantime, it must be assumed that a disintegration of the concretions had taken place.

III. Woman, 65 years. Previously healthy. Symptoms of acute cholecystitis two days before admission to the Surgical Clinic in Lund. Clinical diagnosis: Cholecystitis ac. + cholelithiasis.

On cholecystography 14 days later no filling of the gallbladder was obtained. At its site seven gallstones were observed with calcareously dense peripheral zones. Centrally most of these had a translucent area with signs of stellated outline and undoubtedly due to presence of gas.

When followed up 1 year 4 months later the patient was entirely free from symptoms. All the seven stones appeared on the plain photographs then taken, but in none of them could any central translucency be detected.

In this case, thus, the gas detected on one occasion in the fissures formed in the gallstones was found to be absent after 1 year 4 months, while in other respects the concretions presented an unaltered appearance.

IV. Woman, 55 years. Patient admitted to the Surgical Department of the Falun Hospital on account of abdominal pains of at first an uncertain nature, which later proved to be caused by ovarian cancer. Roentgen examination of the abdomen revealed two large calcareous concretions (Fig. 5).

Six years prior to this the patient had been admitted to the same surgical department under the diagnosis of Cholelithiasis and cholecystitis ac. The cholecystography then performed showed no filling of the gallbladder, but, as was the case now, two calcareous concretions were observed (Fig. 4).

A comparison of the radiograms from these two examinations made at an interval of six years shows that on the occasion of the first examination the upper concretion contained a distinct star-shaped translucency and the lower a rather indistinctly appearing one centrally, while at the second cholecystography both concretions showed homogeneous density without any central translucency but with a somewhat higher content of calcium.

Fig. 4.

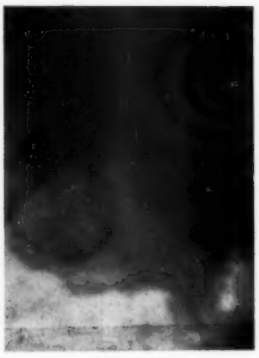

Fig. 5.

In this case, thus, there were first observed two large calcareous stones with gas-filled fissures, then six years later two concretions of the same size but with a slightly higher calcium content and without signs of gas-filled spaces. The most natural assumption is that on both these occasions the same concretions were observed. On account of the long interval between the observations, however, the possibility must also be taken into account that the concretions first observed had been disrupted and that two new ones had been formed.

Of interest in connection with the four cases recorded above is a case reported by HANSSON. Roentgen examination had disclosed a number of calcareous biliary calculi in a woman of 27 years. She was roentgen examined again five years later in connection with an attack of cholecystitis, and the gallstone shadows did not then appear, but on operation three months later gallstones were found that corresponded in number and shape to the roentgen findings five years earlier. HANSSON explains this as being due to a decalcification of the gallstones caused by the cholecystitis, and does not discuss the possibility of disintegration and re-formation. In cases of known gallstone fissuring, however, this latter alternative would appear to be the most ready explanation of the disappearance of gallstone shadows.

V. Woman, 44 years. Typical gallstone attack eight months before the roentgen examination, which was carried out while the patient was being attended for a traumatic complaint in the Orthopaedic Clinic of Lund.

On a plain film taken of the gallbladder region three calcareously dense ring-shadows could be seen. The lowermost, which is partly obscured by colon gas, contains centrally a star-shaped translucency. Here lie three gallstones, one of which has gas-filled fissures.

On re-examination by roentgen $6^1/_2$ months later all three concretions contained central translucencies with suggestions of stellate outline.

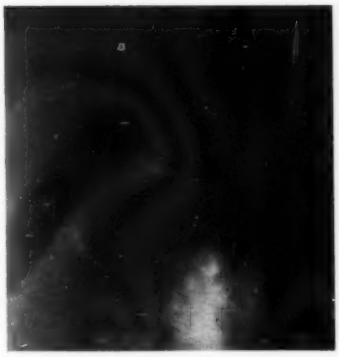

Fig. 6.

Fig. 7.

Hence in this case, examined on two occasions separated by an interval of $6^1/_2$ months, it was found that gas still remained in one of the three concretions observed and that a central translucency had appeared in the other two. It cannot be ruled out here that at the time of the first examination all the concretions contained gas-filled fissures, which in two of the concretions did not appear as central translucencies on account of unfavourable projection conditions prevailing at the first roentgen examination.

VI. Woman, 33 years. Typical gallstone attacks during the four years preceding her admission to the Surgical Department of the Falun Hospital. Clinical diagnosis: Cholelithiasis.

Cholecystography gave a poor filling of a gallbladder with three large concretions, the uppermost of which contains calcium, the two lower ones without detectable calcium but containing central star-shaped translucencies, all of which appears clearer on a plain picture taken later (Fig. 6).

On operation (Dr. K. LAURITZEN) the markedly distended gallbladder was found to contain, besides the large stones, some 70 smaller ones of up to the size of a pea. The specific gravity of the larger calculi was determined in immediate connection with the operation (see Fig. 7). Chemical analysis showed typical cholesterol stones with a slight admixture of pigment calcium, somewhat more abundant in the stone with roentgen indications of containing calcium.

This is accordingly an operatively verified case with three large cholesterol — pigment calcium stones. Two of these, which radiographically showed star-shaped translucencies, had, as might be expected, a very low specific gravity, 1.006 and 1.005 respectively (The sp. gr. of cholesterol is 1.040), while the third concretion, which had not shown signs of containing gas and which had had a higher calcium content, have a specific gravity above 1.060.

Fig. 8.

VII. Woman, 59 years. Had colicky pains of gallstone type some years previously. On two occasions during the week preceding admission to the Surgical Clinic in Lund she had pains under the right arch and shivering attacks. Clinical diag.: Cholelithiasis + pancreatitis.

At cholecystography a fortnight later only a very poor filling of the gallbladder was obtained. Within the gallbladder shadow were observed at least five facetted filling defects the size of cherries — concretions. One of the concretions showed a star-shaped translucency — gas-filled fissure.

On operation the gallbladder was found to contain eight stones. These were roentgen examined and all of them exhibited small fissures containing gas.

Thus, in this operatively verified case with eight gallstones, all having gas-filled fissures, roentgen examination before the operation disclosed star-shaped translucency in only one of the concretions. It is evident that very small gas-filled fissures do not appear at all on the roentgen picture. In fact, it is not at all uncommon to find on roentgen examination of the gallbladder preparation undertaken immediately after cholecystectomy concretions containing small gas-filled fissures which could not be detected at the roentgen examination carried out before the operation. Even largish gas-filled fissures may no doubt escape detection when they have their main extension in a plane at right angles to the central ray. Without doubt, therefore, gas-filled fissures are a commoner phenomenon in gallstones than is indicated by our radiological experience.

One possibility of faulty roentgen diagnosis of biliary calculus lies in the fact that on examination with the patient in the abdominal position with his right side rotated upward the umbilicus can produce a star-shaped translucency projected into the gallbladder area (WELIN). In case II the umbilicus appeared in this way on a radiogram (Fig. 8).

(Cases II, IV and VI have been kindly placed at the writer's disposal by Dr. J. WALDENSTRÖM and Dr. E. SAUL of the Falun Hospital.)

SUMMARY

Of seven cholelithiasis cases in which roentgen examination showed the concretions to contain gas-filled fissures, five have been re-examined at intervals ranging from six months to six years. In four of these cases the gas had then vanished, in two owing to disintegration of the concretions, in two cases through replacement of the gas by other

material. The gas-filled fissures may escape detection on account of their small size as well as owing to unsuitable projection conditions. The umbilicus by simulating the star-shaped translucency of a gas-filled fissure may give rise to an erroneous diagnosis.

ZUSAMMENFASSUNG

Von sieben Cholelithiasis-Fällen, wo die Röntgenuntersuchung gasgefüllte Spalten innerhalb der Konkremente aufzeigte, wurden fünf nachuntersucht, und zwar in Zeitabständen von 6 Monaten bis zu 6 Jahren. In vier von diesen Fällen war das Gas dann verschwunden; in zweien infolge Zerfalls der Konkremente, in zwei Fällen infolge von Verdrängung des Gases durch andere Substanz. Die gasgefüllten Spalten können der Erkennung entgehen, sowohl wegen ihrer geringen Grösse wie auch infolge ungeeigneter Projektionsbedingungen. Der Nabel kann das sternförmige, durchscheinende Bild einer gasgefüllten Spalte vortäuschen und dadurch zu einer irrigen Diagnose Veranlassung geben.

RÉSUMÉ

Sur sept cas de cholélithiase où l'examen aux Rayons Roentgen montrait que les concrétions contenaient des fissures gazeuses, cinq ont été réexaminés à des intervalles variant entre six mois et six ans. Dans quatre de ces cas le gaz avait disparu, deux fois à cause de la désintégration des calculs, et deux fois parce que le gaz avait été remplacé par une autre substance. Les fissures remplies de gaz ne peuvent pas être découvertes à cause de leurs faibles dimensions, ainsi que du fait d'une projection défavorable. L'ombilic, en simulant la transparence en forme d'étoile d'une fissure gazeuse, peut donner lieu à un diagnostic erroné.

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AUS DER RÖNTGENOLOGISCHEN ABTEILUNG DES KRANKENHAUSES DER UNIVERSITÄT LUND, SCHWEDEN. VORSTAND: DOZENT H. HELLMER

EINE NEUE METHODE ZUR ISOLIERTEN OBERFLÄCHENRADIOGRAPHIE

Vorläufige Mitteilung

von

Olle Olsson

Nach dem Gesetz über die Zentralprojektion erhalten filmnahe Objekte die geringste Projektionsvergrösserung und die geringste Randunschärfe. Bei verschiedenem Focus-Filmabstand fällt deshalb der Projektionsrand des Kernschattens filmnaher Objekte praktisch immer auf dieselbe Stelle, wenn der Focus-Filmabstand bei gegebener Focusgrösse ein für jede Focusgrösse und Objektgrösse mathematisch definierbares Minimum nicht unterschreitet. Bei filmfernen Objekten verschiebt sich dagegen der Projektionsrand des Kernschattens mit den Änderungen des Focus-Filmabstandes sehr erheblich.

Auf Grund dieser Tatsache wurde eine neue Methode zur isolierten radiographischen Registrierung filmnaher Objekte ausgearbeitet. Bewegt man nämlich den Focus während der Exponierung in der Richtung des für die Bildwiedergabe angewandten Zentralstrahles (durch Verschiebung der Röhre), so erhält man auf dem Bild die Summe einer unendlichen Zahl für die Bildwiedergabe ungenügender Exponierungen mit verschiedenem Focus-Filmabstand. Bei einem filmnahen Objekt addieren sich jedoch die Exponierungsresultate innerhalb desselben Bezirkes der Filmschicht, und es wird deshalb auf der Aufnahme abgebildet. Filmferne Objekte werden dagegen durch die Bewegung nur während einer Zeit auf die lichtempfindliche Schicht projiziert, die für seine Abbildung nicht ausreicht, und sie erscheinen entweder überhaupt nicht oder nur sehr unscharf auf dem Bild.

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[1] Bei der Red. am 29. V. 1942 eingegangen.

Abb. 1.

Abb. 2.

Abb. 3.

Zur Veranschaulichung dient eine Aufnahme einiger Rippenknochen (Abb. 1) eine der Sternoklavikulargelenke (Abb. 2), und eine des Brustbeins (Abb. 3), die in der oben beschriebenen Weise gemacht wurde.

ZUSAMMENFASSUNG

Vorläufige Mitteilung über eine neue Methode zur isolierten Oberflächenradiographie durch fliessende Bewegung der Röntgenröhre in der Richtung des Zentralstrahles während der Exponierung.

SUMMARY

A new method of isolated radiographic examination of superficially located objects by means of keeping the roentgen tube in a gliding motion in the direction of the central ray during exposure; preliminary report.

RÉSUMÉ

Report préliminaire d'une nouvelle méthode désigné à l'examen isolé radiographique des objets superficiellement situés au moyen d'un mouvement glissant du tube des rayons roentgen dans la même direction que le rayon central pendant l'exposition.